

A-2. ROD for Operable Unit 2, dated June 12, 2001

**EPA Superfund
Record of Decision:**

**SANFORD GASIFICATION PLANT
EPA ID: FLD984169193
OU 02
SANFORD, FL
06/12/2001**

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SITE: Sanford GAS
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OTHER: _____

RECORD OF DECISION

Operable Unit Two
Summary of Remedial
Alternative Selection

for the

Sanford Gasification Plant Site
Sanford, Seminole County, Florida

Prepared by the
United States
Environmental
Protection Agency



RECORD OF DECISION

Declaration

Site Name and Location

Sanford Gasification Plant Site
Sanford, Seminole County, Florida
FLD984169193

Statement of Basis and Purpose

This decision document presents the selected remedial action for the Sanford Gasification Plant Site, in Sanford, Seminole County, Florida, which was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

This decision is based on the Administrative Record for the Sanford Gasification Plant Site. The State of Florida, as represented by the Florida Department of Environmental Protection (FDEP), has reviewed the reports which are included in the Administrative Record for the site. In accordance with 40 CFR 300.430, the State of Florida has been involved in the process and the State has concurred with the selected remedy.

Assessment of the Site

The results of the assessment indicate human consumption of groundwater in the future would present an unacceptable risk. Groundwater in the area is currently not used as a drinking . water source. Actual or threatened releases of hazardous substances from this Site, if not addressed by implementing the response action selected in this Record of Decision (ROD), may present endangerment to public health and welfare, and further harm to the environment.

Description of the Selected Remedy

This remedy is intended to be the second Operable Unit (OU) for this Site. The remedy addresses potential exposures to groundwater contamination and will reduce groundwater contamination levels to comply with appropriate drinking water standards. After reviewing the information available and after careful consideration of the various alternatives, EPA is selecting an alternative which includes: monitoring natural attenuation with institutional controls.

This Alternative would involve:

Following implementation of the removal of surface soils and subsurface "hot spot" areas, addressed in Operable Unit One (OU1), further groundwater sampling is expected to demonstrate a significant decrease of groundwater contamination. Five existing wells, in addition to new wells, will be used to monitor the ground water remediation effort following implementation of the OU1 remedy.

For cost estimating purposes, a total of 22 sampling events has been estimated to monitor the groundwater quality during the 33 years estimated for the remedy to achieve the remedial objectives.

Institutional controls would be implemented to reduce the potential risk associated with the exposure to the groundwater impacts. Institutional controls would include: the formation of a Groundwater Use Advisory Zone (GUAZ) which would include properties that may be affected by the shallow groundwater impacts at the Site. Property owners within the GUAZ will be notified by EPA, in writing, of the potential risk associated with exposure to contaminated groundwater. The notification will include a map showing the location of the contaminated groundwater plume and will advise them not to install groundwater wells near the plume. Annual cleanup updates will be sent to property owners within the GUAZ informing them of groundwater plume conditions and reminding them of the groundwater advisory.

The effectiveness of the remedy will be evaluated by EPA during the Five Year Review evaluation conducted after a remedy has been implemented. The evaluation of the remedy should determine if natural attenuation is occurring according to expectations. Monitoring frequencies may be adjusted depending on the progress of the natural attenuation remedy. Monitoring should continue until remediation goals are achieved. If a review of the effectiveness of the remedy indicates that it is not effective in remediating either the groundwater or preventing further significant expansion of groundwater contamination, the remedy could potentially be modified to include an active remedial measure.

Statutory Determinations

The selected remedy is protective of human health and the environment, complies with Federal and State requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost-effective. EPA has selected an alternative that not only protects human health and the environment but also reduces mobility, toxicity and volume of contaminated groundwater through natural processes. This is believed to be the most effective alternative taking in consideration time to be implemented, cost, and long-term effectiveness.

A review will be conducted within five years after commencement of the remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

- Estimated capital, operation and maintenance (O&M), and total present worth costs; discount rate; and the number of years over which the remedy cost estimates are projected.
- Decisive factors that led to selecting the remedy.

Authorizing Signatures

Pursuant to Section 104 of CERCLA, the President is authorized to undertake actions in response to a threat or potential threat to human health, welfare, or the environment. This authority was delegated to the Administrator of US EPA, then to the Regional Administrators, and through other delegations, the Division Directors of Superfund Program are now authorized to approve these actions.

RECORD OF DECISION

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RECORD OF DECISION DECISION SUMMARY

1.0 SITE LOCATION AND DESCRIPTION

The CERCLIS identification number for this Site is FLD984169193.

The former Sanford Gasification Plant (SGP) was located on the north and south sides of West 6th Street between Holly Avenue and the former Cedar Avenue in Sanford, Seminole County, Florida (Figure 1). The former facility was located adjacent to an unnamed tributary which flows approximately 420 feet to where it merges with Cloud Branch Creek, which flows northward and discharges into Lake Monroe. Bordering the former facility to the north and northwest are properties currently owned by CSX and the City of Sanford. The Site, as defined by CERCLA, includes the former facility, the unnamed tributary which flows into Cloud Branch Creek and Cloud Branch Creek from the unnamed tributary to and including the delta area where Cloud Branch Creek discharges into Lake Monroe.

A portion of the SGP is currently owned by the Florida Public Utilities Company (FPUC) which maintains an office and natural/propane gas distribution facility.

The SGP was owned and operated by Sanford Light and Fuel Company from the 1890's until 1914. From 1914 to 1924, the SGP was owned and operated by Southern Utilities Company. From 1924 until 1928, the City of Sanford owned and operated the SGP. From 1928 until 1932, the City of Sanford owned the SGP, but was operated by the Sanford Gas Company. In 1932, the Sanford Gas Company acquired the title to the SGP and continued operating the SGP until 1944, at which time Sanford Gas Company merged with Florida Power Corporation. Florida Power Corporation owned the Site and continued to operate the SGP until 1946, at which time the SGP was transferred to South Atlantic Gas Company. South Atlantic Gas Company owned and operated the SGP from 1946 to 1949. In 1949, title to the SGP was transferred to Florida Home Gas Company, which continued operating the SGP until approximately 1951, at which time gas manufacturing ceased. Florida Home Gas Company owned the property from 1949 to 1954, at which time it transferred the property title to Sanford Gas Company. In 1965, Sanford Gas Company transferred property title to the Florida Public Utilities Company, which has owned a portion of the former SGP to date. Four parcels south of West 6th Street and east of FPUC property, are also a part of the former SGP, they are owned by Armand Enterprises, Inc.

The U.S. Environmental Protection Agency (EPA), the Florida Department of Environmental Protection (FDEP) and the Potential Responsible Parties (PRPs) have conducted separate environmental investigations at the SGP Site to determine potential impacts to soil, groundwater, surface water and sediments from operations of the former gasification plant.

On July 11, 1997, EPA forwarded Special Notice Letters to FPUC, Florida Power Corporation, Florida Power & Light Company, Atlanta Gas Light Company and the City of Sanford (hereinafter "the Sanford Group"). The Special Notice Letters identified these parties as the PRPs for the SGP Site and requested that they perform a Remedial Investigation/Feasibility Study (RI/FS) to characterize the extent of contamination.

The Sanford Group agreed to negotiate with EPA how to conduct the RI/FS under the terms of an Administrative Order on Consent (AOC). In April 1998, the AOC for the SGP Site RI/FS was signed by all parties. In August 1998, the Sanford Group submitted the final Work Plan. Field work on the Site began in October 1998. Two new addendums to the original Work Plan have been incorporated to accommodate new samples. First, an addendum was made to include samples at an unknown area of contamination located at the City of Sanford Water Treatment Plant. Second, an addendum was made to include a collection of background samples at the Pebble Junction Property, directly south to the FPUC property. Sampling at the Pebble Junction property was delayed because of problems gaining access to that property.

In April 1999, EPA focused the cleanup efforts for the SGP Site into three(3) phases or Operable Units (OUs). EPA is prioritizing its actions on the Site beginning with the impacted soils first (OUI), groundwater second (OU2) and sediments in the Cloud Branch Creek and the delta in Lake Monroe third (OU3).

Figure 1
Site Location Map
Sanford Gasification Plant Site
(Former facility location)

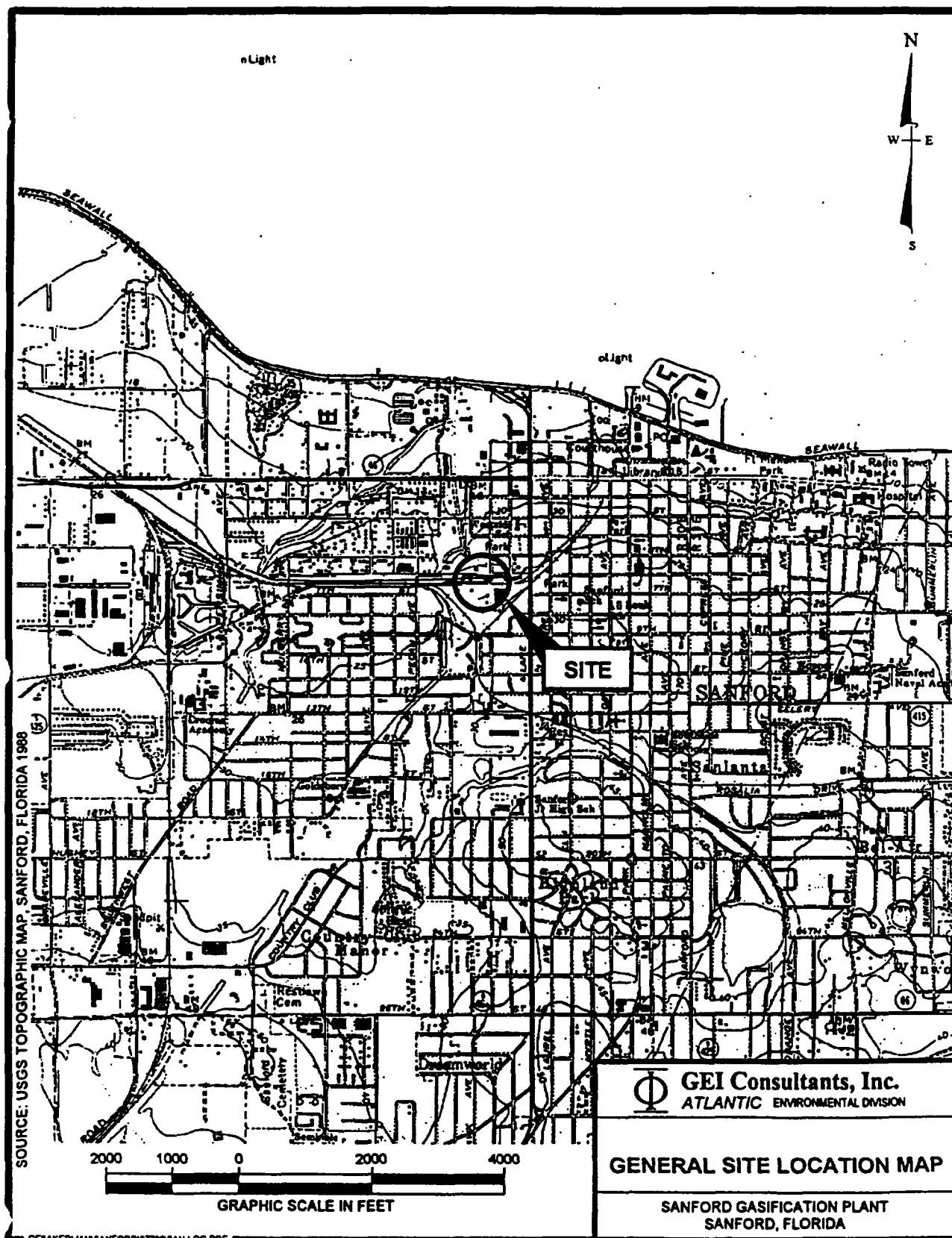
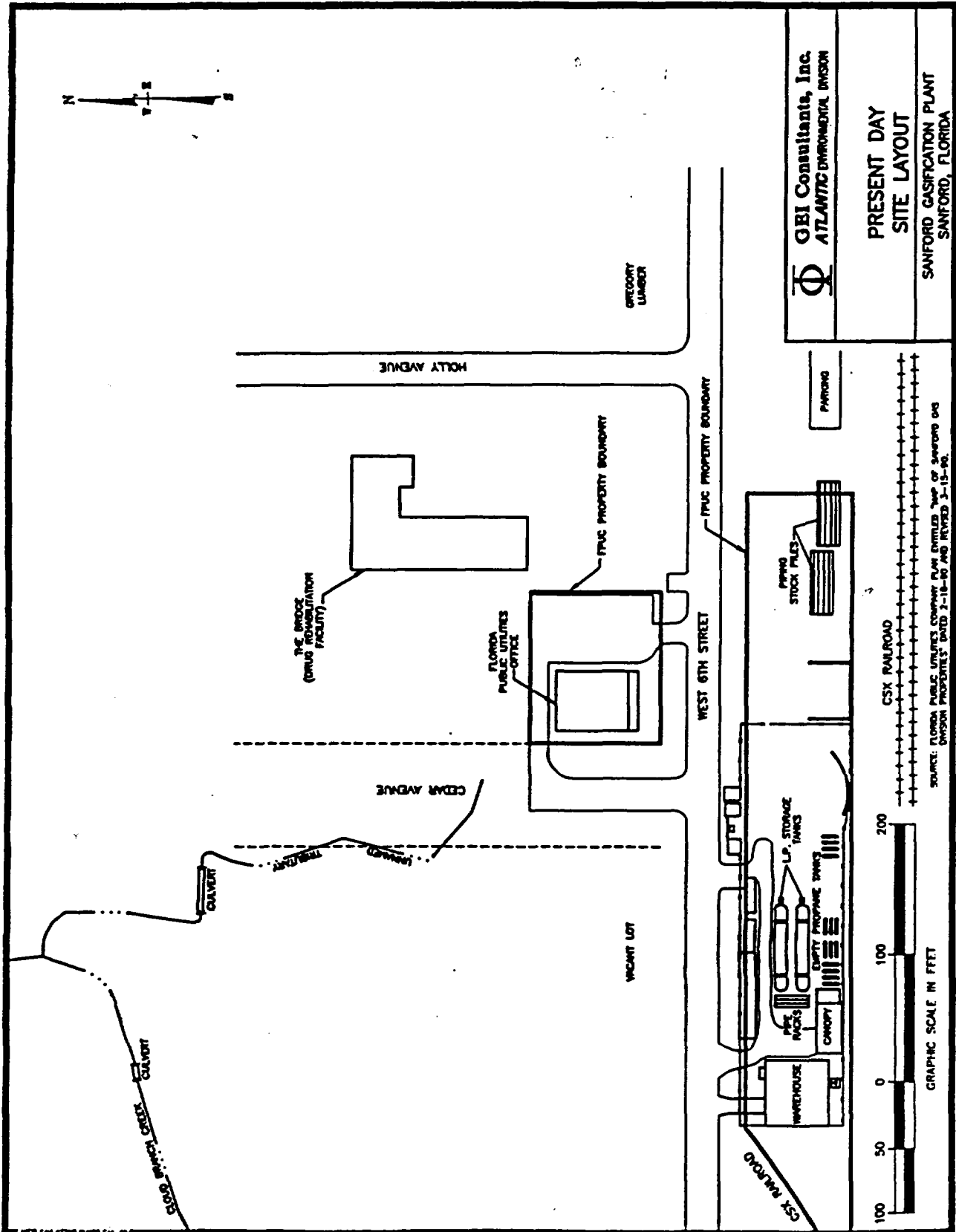


Figure 2
Site Layout Map
Sanford Gasification Plant Site



2.0 SITE HISTORY AND ENFORCEMENT ACTIVITIES

Historically, the SGP was operated from the 1880's to approximately 1951. From the 1880's until 1951, water gas and carbureted water gas were manufactured at the SGP by carbonization or destructive distillation of bituminous coal and coke. At the end of the manufacturing process, gas holder tanks, frequently used to store waste tars and condensates, frequently leaked resulting in contamination.

The Site has been the subject of preliminary investigations to ascertain the nature and extent of the contamination:

Preliminary Assessment

FDEP performed a Preliminary Assessment (PA) in March 1990 to assess the potential for environmental impacts at the former SGP and to make recommendations regarding the need for further action under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA). The investigation involved a review of background information and existing state regulatory files relating to the former SGP. A "windshield survey" was also performed to confirm the location and physical appearance of the Site. The PA document provides a general overview of the site history, typical Manufactured Gasification Plant (MGP) production practices, and common contaminants found at gasification plant sites. FDEP recommended a Site Screening Investigation be performed on-site, in the adjacent drainage ditch and in the nearby Cloud Branch Creek.

Site Screening Investigation

In June 1991, Ecology and Environment, Inc. (E&E) produced a report for a Site Screening Investigation (SSI) for FDEP from a field work event conducted on Fall 1990. The study consisted of background information and FDEP file review, two days of site reconnaissance, and a limited sampling event. The results of E&E's investigation indicated that historic activities, namely generation of coal tar wastes and possible tar sludges at the SGP Site, have released contaminants to the on-site soil and groundwater. The results indicated the potential for contamination of surface water and/or sediments via surface runoff. The SSI concluded that it was evident that soil and groundwater contamination at the SGP Site with respect to polycyclic aromatic hydrocarbons (PAHs), metals, and TRPKs was attributable to coal tar and/or tar sludge sources. Also, the report concluded that a more in-depth investigation to delineate nature and extent of the contamination at the SGP Site was needed.

Soil Boring Investigation

Environmental Consulting & Technology, Inc. (ECT) was contracted by FPUC to perform a soil boring investigation to better delineate vertical and horizontal extent of soil impacts at the former SGP. Using a predefined soil boring grid, a series of 49 solid-stem auger borings were advanced at selected points. Borings were advanced to a depth of 15 ft to 20 ft. Split-spoon soil samples were collected to better delineate the vertical extent of soil contamination. ECT stated in its report that tar was observed in 27 of the 49 borings.

Preliminary Investigation of Surface Soils and Sediments

ECT was contracted by the City of Sanford in 1991 to investigate surface soils and sediments associated with the Cloud Branch Creek drainage system between West 6th and West First Streets. A total of 49 shallow (approximately 1-foot depth) hand augers borings were completed in the study area, with soil/sediment samples inspected for visible tar. Nine borings were completed along the length of the tributary and surrounding drainage basin. In addition to visual inspection, the nine tributary borings were also sampled and analyzed with an organic vapor analyzer (OVA). A series of random borings were also made along Cloud Branch Creek, from West 6th Street to West 1st Street. No analyses for PAHs or volatile organic compounds (VOCs) were performed. The study confirmed coal tar residue along the Unnamed Tributary.

Preliminary Investigation of Groundwater

Atlanta Gas Light Company and FPUC retained Environmental Resources Management, Inc. (ERM) to install five monitoring wells on and adjacent to the Site in June 1992. ERM installed three shallow monitoring wells screened at the water table and two deeper wells screened immediately below the shallowest confining unit. The groundwater from these wells was sampled and analyzed for volatile aromatic compounds and base neutral compounds. Manufacturing gasification plant residuals were not noted in the boring logs for the wells or detected in the groundwater samples collected from the wells.

Contamination Assessment Report

Atlantic Environmental Services, Inc. and Leggette, Brashears, & Graham, Inc. conducted contamination assessment (CA) field activities in 1993 for the Sanford Group. The CA included a well survey, soil gas survey, installation of nine monitoring wells, sampling of 14 monitoring wells, collection of eight surface soil samples, collection of two surface sediment samples, collection of four surface water samples, collection of 11 subsurface soil samples, 27 soil borings, a total of nine transects subsurface soil samples along Cloud Branch Creek, and slug tests in five of the monitoring wells to evaluate hydraulic conductivity.

A review of the St. Johns River Water Management District water well construction permits, and the water well and consumptive use permit inventory, did not identify any water-supply wells within 0.5 mile of the Site.

Impacts related to operations of the former plant were found in on-site groundwater and soil, groundwater north of the Site, sediment from the unnamed tributary and Cloud Branch Creek, and soil along the unnamed tributary and Cloud Branch Creek.

Expanded Site Inspection

In June and July 1996, PRC Environmental Management (EPA's contractor), conducted an Expanded Site Investigation (ESI). The ESI included the collection of thirty-four (34) surface soil samples, collection of fourteen (14) subsurface soil samples, collection of thirty-five (35) sediment samples, collection of twenty-one (21) surface water samples, installation of seven (7) permanent wells and six (6)

temporary wells, and a geophysical survey. The ESI report confirmed results from previous investigations. Data from the ESI report and previous investigations were used to prepare the Hazardous Ranking System Package (HRS) to propose the Site on the National Priorities List (NPL). The Site ranked for the NPL, however the listing was deferred in exchange for the Sanford's Group cooperation with EPA in addressing the Site under the Superfund process.

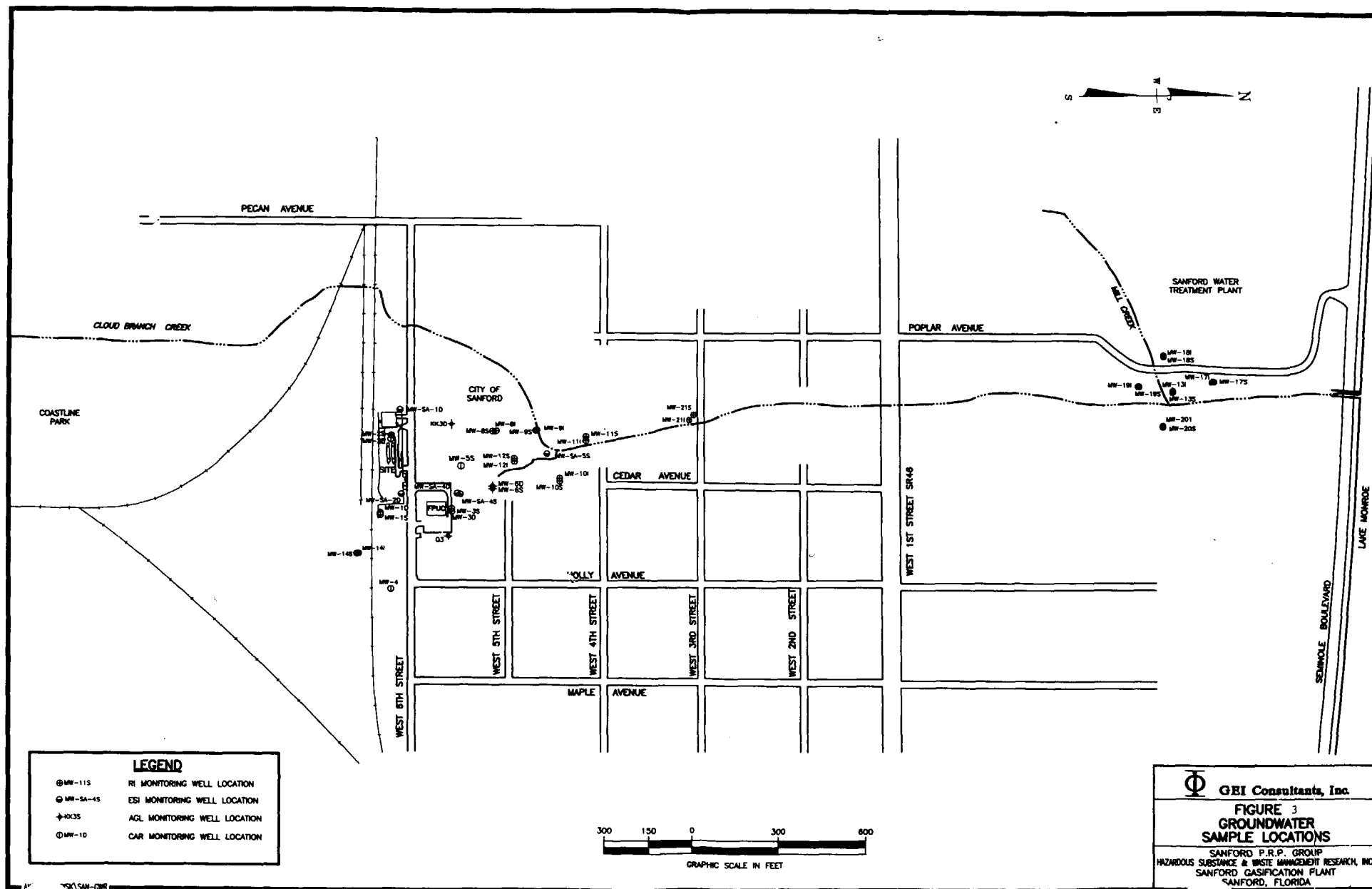
Remedial Investigation

GEI Consultants, Inc., working on behalf of the Sanford Group, completed the Remedial Investigation on July 29, 1999. As a part of this investigation, GEI Consultants, with EPA oversight, collected 133 samples of the soil, groundwater and sediments, and analyzed the samples for metals, cyanide, volatile compounds and semi-volatile compounds. Previous investigation results showed these were the parameters required to determine the extent of contamination at the Site. Sample locations included the former SGP, the unnamed tributary, Cloud Branch Creek and the Cloud Branch Creek outfall in Lake Monroe.

Results from the investigation revealed that source material consisting of tar-saturated soil or sediments, coal/coke, black-stained soil, or sediments with a strong naphthalene odor were identified at some locations extending from land surface, to depths of approximately 30 ft below land surface (BLS) on-Site and along the unnamed tributary downstream to its confluence with Cloud Branch Creek. Source material in sediments along Cloud Branch Creek from the unnamed tributary to Mill Creek exist at various locations from the sediment water interface to a depth of 4ft. Tar saturated nonaqueous phase liquid (NAPL) has been identified in soil near the confluence of Cloud Branch Creek and the unnamed tributary. NAPL has also been identified in a thin shell hash layer near the confluence of Cloud Branch Creek and Mill Creek. The NAPL present at the confluence of Cloud Branch Creek and the unnamed tributary is associated with overlying tar-saturated material at the same locations at a depth of 20.5 feet BLS.

Groundwater impacts are primarily limited to BTEX (benzene, toluene, ethylbenzene and xylene) and PAHs. The impacts exist in a narrow area (100 feet wide or less) extending in shallow groundwater from the Site to MW-11S, downgradient from Cloud Branch and the unnamed tributary confluence (CBC/UT). In addition, groundwater impacts in the intermediate depth extend downgradient of MW-11I and MW-21I (see Figure 3). The extent and magnitude of groundwater impacts could be related to natural attenuation processes at the Site. Therefore, natural attenuation parameters were analyzed in groundwater samples collected during the RI.

Natural attenuation of groundwater impacts has been demonstrated in the vicinity of the Site and downgradient of the CBC/UT confluence. Concentrations of site organic contamination in the wells near or in Site source area are significantly higher than the concentrations in wells downgradient of the "hot spots." Historical groundwater data and the site 7 conceptual model indicate the BTEX and PAH concentrations in monitoring wells within the source areas in the vicinity of the Site have generally decreased over time. The historical data also indicates that groundwater impacts have been at the former facility for a long time and have weathered or attenuated to the current plume configuration.



3.0 HISTORY OF COMMUNITY RELATIONS

To date, three (3) Open House Meetings and two Proposed Plan Meetings have taken place at the West Sanford Boys and Girls Club. The first meeting was held on September 23, 1998, to inform the community of the status of the enforcement action and to announce the upcoming sampling event for the RI. A second meeting was held on May 12, 1999, for the purpose of informing the community about the steps to form a Community Advisory Group (CAG). A third meeting was held on September 22, 1999, to inform the community about the results of the RI. A Proposed Plan Meeting to present the cleanup alternatives for OU1 was held on April 18, 2000. The most recent meeting, OU2 Proposed Plan Meeting, was held on February 7, 2001, to inform the community about EPA's preferred alternative for the cleanup of the groundwater contamination at the Site.

Community interviews were conducted with local officials and residents in September 1998. Using information collected during these interviews, EPA developed a community relations plan to address the concerns and information needs of the community. It also identifies opportunities for the community to take part in cleanup decisions about the Site and the opportunity to form a CAG.

Fact Sheets for the Site have been issued in September 1998, September 1999, April 2000 and January 2001. A Public Notice, with the purpose of announcing the Proposed Plan for OU2, was advertised in the Seminole Herald. The comment period for the Proposed Plan for the OU2 started January 24, 2001 and ended February 24, 2001. No comments from the community were received during the comment period.

The Administrative Record (AR) is located in Downtown Sanford at the North Branch Library on North Palmetto Avenue.

4.0 SCOPE AND ROLE OF OPERABLE UNIT TWO ACTION

This ROD addresses OU2 for groundwater contamination at the Site. This OU does not directly involve the soil cleanup; however, subsurface soil remedial goal options for OU1 ROD do affect the selection of the remedial goals option for groundwater protection. As part of the development for groundwater goals for OU2, review was conducted for consistency of soil goals in OU1 and groundwater goals in OU2.

Though the planned action for OU1 (soils) for this Site addresses surface soil and subsurface contamination, groundwater contamination mitigation will likely occur because the subsurface soil will be cleaned up. This OU2 remedy will insure the groundwater goals are achieved through monitoring of natural attenuation and institutional controls.

This planned action is necessary to protect human health and the environment from groundwater impacts. An additional ROD is anticipated for this Site to addresses sediment contamination along the Cloud Branch Creek from the confluence with the unnamed tributary to the delta with Lake Monroe as Operable Unit Three (OU3).

5.0 SUMMARY OF SITE CHARACTERISTICS

5.1 Geology

The geology under the former facility is discussed in greater detail in the Remedial Investigation (RI) report. During the RI, the GEI Consultants collected data to specifically characterize the geology in the area around the site. The geology under the former gasification plant consists primarily of Plio-Pleistocene aged sand and shell hash with lesser amounts of clay, rock silt, and organic materials. These sediments overlie the Miocene-aged clay of the Hawthorn Group. The clay layer is laterally continuous across the former facility.

Debris was found in the surficial sands in many of the borings collected. Debris included wood, brick, glass, rock, and concrete rubble. The thickness of the sands containing some debris ranged from less than 2 ft up to 12 ft.

5.2 Hydrogeology

Three hydrogeologic units are located in the site vicinity; the Surficial Aquifer, the intermediate System, and the Floridan Aquifer System. In Seminole County, the Surficial System is primarily composed of Pleistocene to recent age fine to coarse-grained quartz sands. In Seminole County, the Surficial Aquifer is an unconfined aquifer that typically ranges between 10 and 75 feet in thickness. The Surficial Aquifer System is primarily recharged by the direct infiltration of rainfall. Across Seminole County, water levels in the Surficial Aquifer System vary between land surface and 40 feet below ground surface. Naturally occurring iron concentrations in groundwater from the Surficial Aquifer System limits its use to primarily lawn irrigation, and less frequently domestic and livestock applications.

The Surficial Aquifer is underlain by the Intermediate System, which consists of the blue . clay and shell beds of differentiated Pliocene to Miocene-age deposits and the blue-to-gray, calcareous clays and interbedded cream to gray, sandy limestone of Miocene-age Hawthorn Group. The clays of the Intermediate System are the upper confining sequence for the underlying Floridan aquifer system. Locally, the sandy limestone within the Intermediate System may be capable of yielding significant quantities of water. However, the low-permeability clay units within the Intermediate System separate the Surficial and the Floridan Aquifer System. The Intermediate System is present throughout most of the Seminole County with a thickness of approximately 150 feet. However, in the northern part of the county, along the St. John's River and Lake Monroe, the intermediate deposits have been eroded.

The Intermediate System is underlain by the Eocene-age carbonate units of the karstic Floridan Aquifer System. The Floridan Aquifer System included cream-to-tanish gray, soft-to-hard, granular porous, marine limestones of the Ocala Group (which may be absent in the northern part of Seminole County); the light gray-to-brown, porous-to-dense, granular-to-chalky limestones of the Avon Park Limestone; and the alternating layers of hard, brown, porous crystalline dolomites and hard, cream-to-tan, chalky limestone/dolomitic limestones of the Lake City Limestone. The top of the Floridan Aquifer System generally occurs at depths of between 74 and 85 feet bgs in the Site vicinity.

Groundwater in the Floridan Aquifer System exists under artesian conditions. Given that the Floridan aquifer System potentiometric surface is similar to the Surficial aquifer water level elevations noted in the vicinity, downward leakage from the Surficial Aquifer System would not be expected.

Surficial aquifer groundwater in the area of the former facility is not used as a drinking water source. No surficial aquifer system drinking water wells have been documented within four (4) mile radius of the Site.

The RI groundwater investigation focused on the surficial aquifer and the most recent groundwater elevations and contours are plotted in the RI report. On December 8, 1998 groundwater elevations measured in the vicinity of the Site and downgradient ranged from a high of 21.82 ft above mean sea level (MSL) south of West 6th Street to a low 9.82 ft above MSL north of the confluence of Cloud Branch Creek and the unnamed tributary. On June 4, 1999 groundwater elevations in the vicinity of the Site and downgradient range from a high of 21.24 ft MSL south of West 6th Street to a low of 7.58 ft MSL near the West 3rd Street bridge. Groundwater elevations at both occasions indicate groundwater flow, in the surficial aquifer, was toward the unnamed tributary and Cloud Branch Creek (immediately downstream of its confluence with the unnamed tributary).

Groundwater elevations measured in December 1998 and June 1999, in the vicinity of the confluence of Cloud Branch Creek and Mill Creek illustrated that groundwater flow in the surficial aquifer is toward the creeks.

5.3 Soil Contamination

The majority of the former gasification plant structures were removed prior to 1962, and no above ground structures containing plant related residuals exist today. Previous investigations confirmed that no subsurface structures containing source materials are present today. However, source material has been identified during the investigations as tar-saturated soil or sediment (including sheen), coal/coke, and black stained soil or sediment with strong naphthalene odor. These source materials have been identified in soil on-Site, soil and sediment along Cloud Branch Creek, and sediments along Cloud Branch Creek downgradient of the confluence with the unnamed tributary. Tar-saturated or black stained soil source material that exists on Site and along the unnamed tributary to the confluence with Cloud Branch Creek has been identified to extend from the land surface to as deep as the top of the confining unit (to a depth of approximately 30 ft BLS) at some locations on Site. Source material in sediments along Cloud Branch Creek exists from the sediment water interface up to a depth of at least 4 ft. Tar-saturated soil and NAPL are present to the top of the confining unit (to a depth of approximately 30 ft BLS) near the confluence of the unnamed tributary and Cloud Branch Creek. A thin layer of NAPL (less than 2 inches thick) was observed in the shell hash layer on the top of the confining unit at MW-131. This NAPL appears to be confined to a small area since it was not observed in any of the borings installed around of the perimeter of MW-131. The primary chemical constituents of the source material include VOCs (primarily benzene, toluene, ethylbenzene, and xylenes) and PAHs.

5.4 Surface Soil Contamination

As agreed between EPA and the Sanford PRP Group, due to the nature of the unnamed tributary, an ephemeral drainage structure which carries only intermittent surface water flow, the sediment samples collected from the unnamed tributary during the CAR and the ESI were evaluated as surface soil samples.

Surface soil samples were collected from the Site, along the unnamed tributary, around the confluence of the unnamed tributary and Cloud Branch Creek, and upgradient of the Facility.

MGP constituents detected in surficial soil are limited primarily to PAHs. Benzene, toluene, ethylbenzene and xylene (BTEX) were detected in only one surface soil sample, a control sample, during the Expanded Site Investigation (ESI). Surficial PAHs have generally been delineated along the FPUC property south and north of West 6th Street. However, relatively elevated levels of PAHs were detected west of FPUC office, and to the east, west, and north of the toe area (area where Cloud Branch Creek and the unnamed tributary merge).

Based on the data from the CAR and the ESI, the eight RCRA metals (arsenic, cadmium, chromium, lead, mercury, silver, barium and selenium) and copper, iron, manganese and zinc were the only metals proposed to be analyzed during the RI. The CAR, ESI and RI metal data for surface soil were evaluated by comparing the results with EPA Region's 4 screening criteria (EPA Region 3 RBC Table Residential values). Antimony, arsenic, chromium, iron, lead, and manganese were detected in more than three surface soil samples (on and off-site) at concentrations above the screening criteria. The highest antimony concentration was detected in off-site sample SD-UN-05 (considered a surface soil sample for purpose of the OU1 soil cleanup) along the unnamed tributary near its confluence with Cloud Branch Creek. The highest arsenic concentration was detected in an on-site surface soil sample SS-CS-02 along the southern property boundary of the Site, adjacent to the CSX Rail Road. The highest chromium, iron, lead and manganese were detected in off-site sample SS-27 just beyond the confluence of Cloud Branch and the unnamed tributary. The highest background concentrations for arsenic, iron and mercury exceed the screening criteria. Far fewer surface soil samples had arsenic and iron concentrations exceeding the highest background concentration than the number of samples exceeding screening criteria.

5.5 Subsurface Soil Contamination

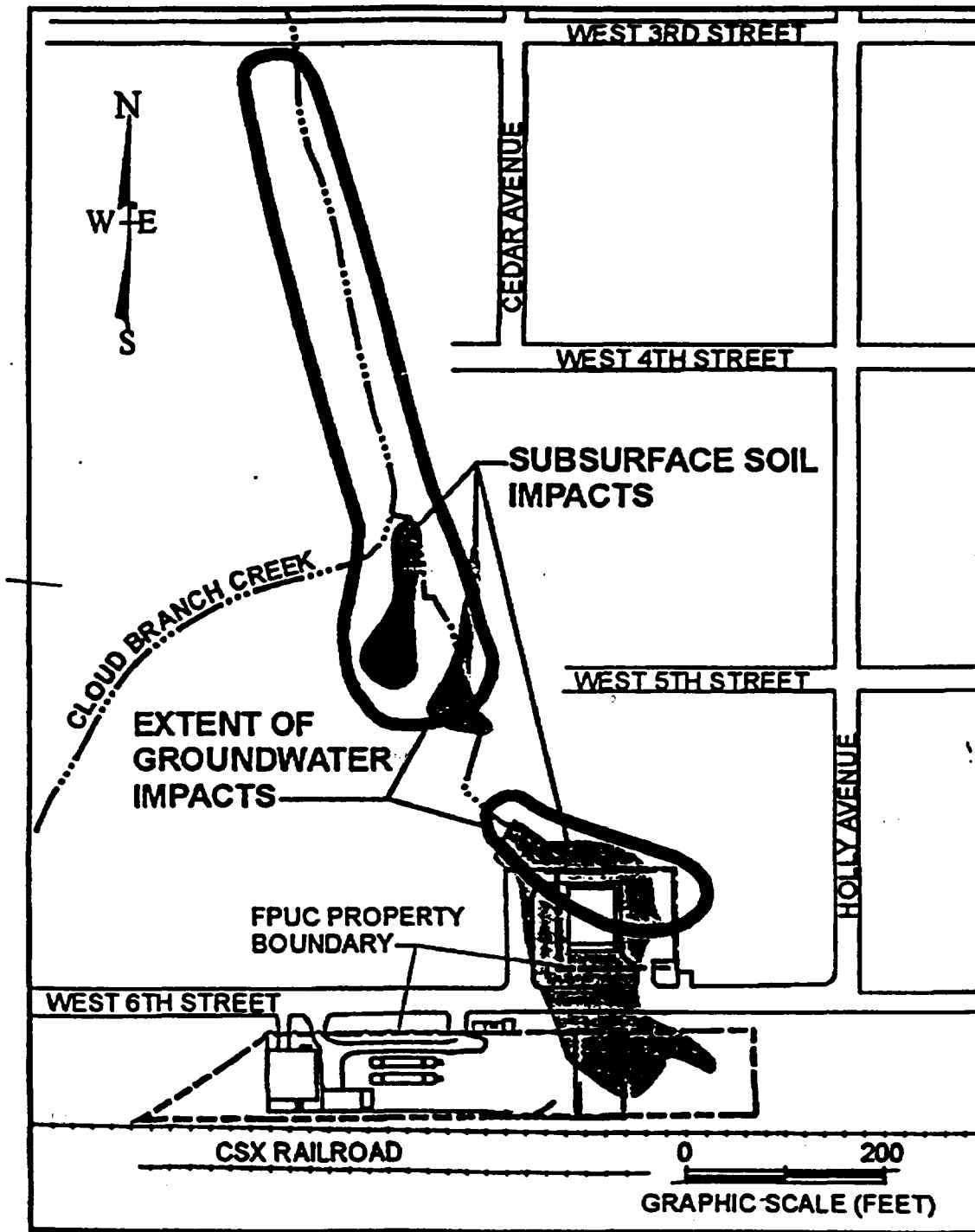
Figure 4 presents the areas of subsurface soil that contained concentrations of COCs above Remedial Goal Options (RGOs).

Subsurface soil samples were collected from 15 boring locations, primarily in connection with the installation of the monitoring wells.

The highest concentrations of BTEX and PAHs detected at the former facility were in the subsurface soil samples collected from areas where tar and/or NAPL were observed.

Subsurface soil samples collected to date are sufficient to delineate and characterize subsurface soil impacts attributable to MGP operations. Sources used to delineate such impacts include multiple soil borings and monitoring wells installed at the former facility. In general, in the area south of the confluence

Figure 4
Extent of Groundwater and Subsurface Soil Contamination
Sanford Gasification Plant Site



of Cloud Branch Creek and the unnamed tributary, the analytical data generated during the RI confirm the horizontal and vertical extent of subsurface soil impacts observed in previous investigation soil borings. In addition, the RI data identified an area of subsurface soil impacts in the vicinity of monitoring well MW-11I (SB-11I), northwest of the Site, and at monitoring well MW-13I (SB-13I), at the confluence of Mill Creek and Cloud Branch Creek. At SB-11I, materially elevated levels of PAHs were detected at 5 to 7 feet BLS. Concentrations of PAHs decreased dramatically in the deeper samples at SB-11I. At SB-13I, NAPL was detected in the 6 inches of shell hash found at 20.5 ft BLS, immediately above the clay confining unit. NAPL was not present either above or below the thin shell hash unit found at SB-13I.

None of the metals detected in on-site subsurface soil samples exceeded Region 4's screening criteria. Arsenic, iron and lead were the only metals detected in off-site subsurface soil samples above the screening criteria. The highest arsenic, iron, and lead concentrations were detected in off-site subsurface soil sample SB-19I (5-7) located near the confluence of Cloud Branch Creek and Mill Creek.

5.6 Groundwater Contamination

Based on analytical results, groundwater impacted by volatile or semivolatile compounds, primarily BTEX and PAHs, is present in a fairly narrow plume (approximately 100 ft wide or less) extending from the northern portion of the Site (FPUC office building and parking lot) downgradient to monitoring well pair MW-11S and MW-11I. In the wells closest to the Site, impacts are present in shallow wells MW-3S and MW-SA-4S, but are not present in the deeper wells, (MW-3D and MW-SA-4D) at those same locations. Further downgradient, near the confluence of Cloud Branch Creek and the unnamed tributary, BTEX and PAH impacts are more significant in the intermediate wells (MW-12I and MW-15I). These BTEX and PAH groundwater impacts continue downgradient from MW-12I and MW-15I, along a narrow band, to monitoring well pair MW-11S and MW-11I. The most downgradient (leading) edge of shallow groundwater impacts, as defined by detected BTEX and PAH concentrations, extends beyond monitoring well MW-11S, but not to the downgradient well MW-21S. The leading edge of intermediate groundwater impacts, as defined by BTEX and PAH concentrations detected in the intermediate wells which are screened on the top of the confining unit, extent to MW-21I, which has the following MGP-related constituent concentrations: benzene, 28 ug/L; BTEX, 32 ug/L; naphthalene, 3.7 ug/L; and non-carcinogenic PAHs, 791 ug/L. Although no monitoring wells have been installed for a distance of more than a thousand feet downgradient of MW-21I, indirect evidence of the absence of significant groundwater contamination in most of the area is provided by organic vapor and soil contaminant concentration data from soil boring SB-16I, located several hundred feet downgradient of MW-21I.

Groundwater impacted by BTEX and PAHs exists near the confluence of Cloud Branch and Mill Creeks. Subsurface soil boring at MW-13I revealed NAPL just above the confining unit. However, MW-13I, which was screened just above the NAPL, has only low levels of naphthalene and other PAHs, as do MW-13I, MW-19S and MW-19I. Nearby monitoring well pairs MW-17S, MW-17I, MW-18S, MW-18I, and MW-20S and MW-20I have no detectable levels of BTEX or PAHs. The NAPL present in the shell hash unit at MW-13I does not appear to materially impact groundwater quality outside the shell hash unit.

Historical groundwater data indicate that BTEX and PAH concentrations in monitoring wells within the source areas in the vicinity of the Site have generally decreased over time. BTEX and naphthalene concentrations in groundwater from monitoring wells MW-3S, MS-SA-4S, and MW-SA-5S have decreased

over time. These wells are located in the source areas (hot spots). Benzene and naphthalene concentrations have oscillated between low and non-detect in groundwater collected from monitoring well Q3. Well Q3 is on the edge of the groundwater plume.

Monitoring wells (MW-13S, MW-13I, MW-17S, MW-17L, MW-18S, MW-18I, MW-19S, MW-19I, MW-20S and MW-20I) at the Cloud Branch Creek/Mill Creek confluence were sampled once. BTEX was not detected and the highest naphthalene concentration detected (34 ug/L) is below the RGO of 100 ug/L, indicating that the source of impacts in this area is highly weathered and has attenuated to levels below the RGOs.

Natural attenuation processes includes a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil or groundwater. These in situ processes include: biodegradation, dispersion, dilution, sorption, volatilization, radioactive decay, and chemical or biological stabilization, transformation, or destruction of contaminants. Groundwater monitoring is a critical component of a natural attenuation remedial action to ensure the remedy is protective and natural processes are reducing contamination levels as expected.

Natural attenuation parameters were analyzed in groundwater samples collected during the RI. Those data and historical data for Site COCs are summarized in Table 2 of the OU2 FS report and results are showed in Table 3 of the same report. Those and the historical data indicate that the groundwater impacts have been at the Site for a long time and have attenuated to the current plume configuration (see Figure 4). The plume configuration may be partially explained by evaluating natural attenuation processes at the Site.

Arsenic, barium, cadmium, cyanide, iron and manganese were detected in monitoring wells at concentrations exceeding the EPA Region 4 screening criteria (which are the April 1999 EPA Region 3 RBC Table Tap Water values at an HQ of 0.1 for noncarcinogens and risk of 1×10^{-6} for carcinogens).

TABLE 1: CONTAMINANTS OF POTENTIAL CONCERN IN GROUNDWATER SAMPLES COLLECTED DURING THE REMEDIAL INVESTIGATION		
CONTAMINANT	FREQUENCY OF DETECTION	RANGE OF DETECTED CONCENTRATIONS (ug/L)
Acenaphthene	12/37	5 - 660
Acetone	2/37	41 - 620
Arsenic	2/29	12 - 26
Benzene	5/37	2.8 - 2000
Butylbenzene, -	2/29	1.8 - 12
Cadmium	4/37	2 - 3

CONTAMINANT	FREQUENCY OF DETECTION	RANGE OF DETECTED CONCENTRATIONS (ug/L)
Cyanide	7/37	10 - 300
Dichloroethane, 1, 2-	2/37	21 - 39
Ethylbenzene	9/37	1.2 - 1,400
Fluorene	7/37	20 - 220
Iron	34/37	50 - 30,000
Isopropylbenzene	7/37	2.2 - 130
Manganese	28/37	13 - 770
Methylene chloride	7/37	4 - 7
Methylnaphthalene, 1-	11/37	5- 1,000
Methylnaphthalene, 2-	7/37	9 - 900
Naphthalene	14/37	3.7 - 11,000
Phenanthrene	9/37	6 - 160
Propylbenze, -	4/37	1.8 - 34
Toluene	3/37	1.2 - 120
Trirhethylbenzene, 1 ,2,4-	9/37	1.5 - 340
Trimethylbenzene, 1 ,3,5-	7/37	1.4 - 110
Xylenes, Total *	8/37	13 - 310

* Includes Xylene, —, o- and p-.

6.0 CURRENT AND POTENTIAL FUTURE SITE AND RESOURCES USES

Currently, a portion of the former SGP is owned by the FPUC which maintains an office and natural/propane gas distribution facility. The other portions of the Site are currently owned by the City of Sanford, CSX Transportation and Armand Enterprises. However, none of these portions are currently in use with the exception of Armand Enterprises' parcel, which is being used by FPUC as parking lot for its employees.

The Site is zoned as Restricted Industrial (RI-1) and General Commercial (GC-2). The Restricted Industrial designation is described as areas which "are intended for light wholesale and manufacturing uses and related accessory use." The General Commercial (GC-2) designation is described as areas which "accommodate community-oriented retail sales and services; highway-oriented sales and services; and other general commercial activities." Other adjacent land uses include multiple family residential, general commercial, and restricted industrial land use.

The surficial aquifer is classified by FDEP as a Class G-II (potable water use). However, groundwater in the area of the former facility is not used as a drinking water source since there is community-supplied water. No surficial aquifer system drinking water wells have been documented within four mile radius of the Site.

7.0 SUMMARY OF SITE RISK

CERCLA directs EPA to conduct a Baseline Risk Assessment (BRA) to determine whether a Superfund Site poses a current or potential threat to human health and the environment in the absence of any remedial action. The BRA provides the basis for taking action and indicates the exposure pathways that need to be addressed by the remedial action. This section of the ROD reports the results of the BRA conducted for the first two OUs of this Site. The principal components of the conceptual model for the Site is to assume that surface soil, subsurface soil, sediments and groundwater are contaminated, and that humans could be exposed to contamination through ingestion and/or dermal contact and inhalation in the case of air. The model also studies current and future scenarios for different receptors. The potential noncarcinogenic and carcinogenic risk elements were combined across exposure pathways for each of the media and for each of the potential receptors at the Site as well.

7.1 Contaminants of Concern

The various COPCs identified in Table 1 were evaluated for the Site risk. Contaminants appearing in Table 2 are a result of the risk assessment indicating that the contaminant might pose a significant current or future risk or could contribute to a cumulative risk which is significant for present and/or future exposure. One of the criteria for a significant risk was a carcinogenic risk level above the acceptable risk range, i.e., 1×10^{-4} to 1×10^{-6} , or a hazard quotient (HQ) greater than 1.0. Drinking water standards and Lifetime Health Advisories were also taken in consideration to calculate cleanup levels for future water consumption and for the selection of COCs. Table 2 shows the COCs selected for the groundwater medium.

TABLE 2: CONTAMINANTS OF CONCERN IN GROUNDWATER		
CONTAMINANT	FREQUENCY OF DETECTION	RANGE OF DETECTED CONCENTRATIONS (ug/L)
Benzene	5/37	2.8 - 2,000
Naphthalene	14/37	3.7 - 11,000
Ethylbenzene	9/29	1.2 - 1,400

7.2 Exposure Assessment

Regardless of application, all risk assessments have a common basic principle, the concept that complete pathways from environmental release to human exposure must exist, or else human risks are not present. That is, regardless of the intrinsic toxicity of a compound, without plausible exposure scenarios, the compound will not exert its toxic effects. The BRA evaluates in a conservative manner, in accord with EPA requirements, the potential exposure, and is used as a tool for site-specific decisions. Whether a chemical is actually a concern to human health and the environment depends upon the likelihood of exposure, i.e., whether the exposure pathway is currently complete or could be complete in the future. A complete exposure pathway (a sequence of events leading to contact with a chemical) is defined by the following four elements:

- A source and mechanism of release from the source,
- A transport medium (e.g., surface water, air) and mechanisms of migration through the medium,
- The presence or potential presence of a receptor at the exposure point, and
- A route of exposure (ingestion, inhalation, dermal absorption).

An evaluation was undertaken of all potential exposure pathways which could connect chemical sources at the Site with potential receptors. All possible pathways were first hypothesized and evaluated for completeness using the above criteria. The current pathways represent exposure pathways which could exist under current Site conditions while the future pathways represent exposure pathways which could exist, in the future, if the current exposure conditions change. Exposure by each of these pathways was mathematically modeled using generally conservative assumptions. Residential exposures were evaluated in the BRA

TABLE 3: POTENTIAL EXPOSURE PATHWAYS		
MEDIA	SCENARIO	RECEPTOR
Surface Soil	Current	Commercial Worker (on-Site/off-site) Trespasser/Visitor (on/off-site)
Surface Soil	Future	Construction Worker (on/off-site) Child, Resident (on/off-site) Adult, Resident (on/off-site) Aggregate resident (on/off-site)
Subsurface Soil	Current	None
Subsurface Soil	Future	Construction Worker (on/off-site)
Sediment	Current	Adolescent Trespasser (off-site)
Sediment	Future	Construction Worker (off-site)
Groundwater	Current	None
Groundwater	Future	Construction Worker (on/off-site) Irrigation/maintenance Worker (on/off-site)
Groundwater	Future	The Baseline Risk Assessment did not quantify the risk associated with residential ingestion of the groundwater. Because of this EPA used ARARs such as MCLs and other health-based numbers, i.e. Lifetime Health Advisories to determine levels of acceptability and remedial goals.
Surface Water	Current	Adolescent Trespasser/Visitor (off-site)
Surface Water	Future	None

The various environmental media at the former facility may have been affected by direct historical site disposal practices, by normal facility manufacturing operations and by indirect sources such as soil runoff to surface water or the leaching of contaminants from soil to groundwater.

The exposure points for the BRA are located at either on-Site or off-site locations. The exposure routes per EPA practice, are assumed to be combined oral (i.e., ingestion) and dermal routes for surface soil, subsurface soil, groundwater, surface water and sediment, as well as the inhalation pathway for air which may contain volatiles or particulates.

The exposure point concentrations (EPCs) for each of the chemicals of concern and the exposure assumptions for each pathway with an unacceptable risk or hazard were used to estimate the chronic daily intakes for the potentially complete pathways (the exposure assumptions for the pathways of concern can be found in Appendix C). The EPCs are summarized below for those contaminants and exposure pathways that were found to present a significant potential risk. The BRA is based on the reasonable maximum exposure (RME) that may be encountered during the various Site use scenarios. The RME concentrations are either the calculated 95% Upper Confidence Limit of the arithmetic mean or the maximum concentration detected during sampling. The intent of the RME is to estimate a conservative exposure case (i.e., well above the average case) that is still within the range of possible exposures. If the calculated UCL exceeded the maximum level measured at the Site, then the maximum concentration detected was used to represent the reasonable maximum concentration. The chronic daily intakes were then used in conjunction with cancer slope factors and noncarcinogenic reference doses to evaluate risk. Aluminum, barium, copper and vanadium were included as a contaminant of potential concern in groundwater at the request of the State of Florida.

A. Surface Soil Exposure

Surface soil at a site typically is the most readily accessible environmental medium and, thus, poses the most significant exposure potential. However, the likelihood of actual exposure will be influenced by characteristics such as landscaping, paving and buildings location. Current exposure to on-Site or off-site surface soil near the Sanford Site was quantitatively evaluated for a commercial worker scenario and a trespasser/visitor scenario. Future exposure to on-Site and off-site surface soil was quantitatively evaluated for a potential resident (child, adult or aggregate), a potential construction worker, and qualitatively evaluated for the commercial worker and the trespasser/visitor, since exposures in the future for these two receptor groups are expected to be equal or less than the current exposure.

B. Subsurface Soil Exposure

The construction worker is the only potential exposed population for direct exposure to subsurface soil. Since current construction activities are not occurring or planned at this time, only future exposure of construction workers to any on-Site and off-site subsurface soil was quantitatively evaluated.

Exceedance of groundwater RGOs and ARARs were examined to evaluate what surface and subsurface soil impacts in OU1 could be leaching to groundwater in excess of groundwater RGOs and ARARs. Only two COCs, benzene and naphthalene, were detected in groundwater samples above the groundwater RGOs. In addition, benzene and ethylbenzene (another MGP related constituent) were detected in groundwater above ARARs. Therefore, subsurface soil levels were calculated in this assessment for

benzene, ethylbenzene and naphthalene. Total xylenes, another MGP related constituent detected in groundwater, did not exceed its ARAR value of 10,000 ug/L. While total xylenes concentrations in groundwater did not exceed the ARAR, a subsurface soil remedial goal for groundwater protection was generated to assure the 10,000 ug/L drinking water maximum contaminant level for total xylenes was not to exceeded in the future.

C. Groundwater Exposure

Current exposure to groundwater was not evaluated, since there is not a complete exposure pathway at this time. Groundwater in the area of the former facility is not used as a drinking water source since there is community-supplied water. No surficial aquifer system drinking water wells have been documented within four mile radius of the Site. The Floridan Aquifer is the principal source of potable water in the Sanford area. Since, the surficial aquifer is classified by FDEP as a Class G-II (potable water use), the RGOs selected will address groundwater cleanup to applicable drinking water standards.

TABLE 4: ON-SITE EXPOSURE POINT CONCENTRATIONS IN GROUNDWATER		
CONTAMINANT	EPC Value (ug/L)	Max. or 95% UCL
Acenaphthene	74	Maximum
Benzene	2,000	Maximum
Cadmium	3.0	Maximum
Cyanide, Total	180	Maximum
Dichloroethane, 1,2	39	Maximum
Ethylbenzene	570	Maximum
Iron	50,000	Maximum
Manganese	770	Maximum
Methylene Chloride	7.0	Maximum
Methylnaphthalene, 1-	300	Maximum
Methylnaphthalene, 2-	390	Maximum
Naphthalene	2,400	Maximum
Phenanthrene	24	Maximum
Propylbenzene, -	15	Maximum
Trimethylbenzene, 1,2,4-	22	Maximum
Trimethylbenzene, 1,3,5-	6.0	Maximum

TABLE 5: OFF-SITE EXPOSURE POINT CONCENTRATIONS IN GROUNDWATER		
CONTAMINANT	EPC Value (ug/L)	Max. or 95% UCL
Acenaphthene	174	95% UCL
Acetone	27	95% UCL
Arsenic	6.5	95% UCL
Barium	105	95% UCL
Benzene	14	95% UCL
Buthylbenzene, -	1.9	95% UCL
Buthylbenzene, tert-	2.3	95% UCL
Cadmium	0.74	95% UCL
Cyanide, Total	19	95% UCL
Dichloroethane, 1,2-	2.0	95% UCL
Ethylbenzene	297	95% UCL
Fluorene	39	95% UCL
Iron	36,000	Maximum
Isopropylbenzene	12	95% UCL
Manganese	540	Maximum
Methylene Chloride	5.5	95% UCL
Methylnaphthalene, 1-	269	95% UCL
Methylnaphthalene, 2-	50	95% UCL
Naphthalene	8,224	95% UCL
Phenanthrene	31	95% UCL
Propylbenzene, -	2.7	95% UCL
Toluene	3.4	95% UCL
Trimethylbenzene, 1,2,4-	32	95% UCL
Trimethylbenzene, 1,3,5-	7.8	95% UCL
Xylene, m & p	18	95% UCL
Xylene, o-	10	95% UCL

D. Sediment Exposure

Current exposure to off-site sediment, such as may occur in the drainage ways or Cloud Branch Creek was quantitatively evaluated for a trespasser/visitor, such as may be represented by a nearby childhood resident. Future exposure to off-site sediment was quantitatively evaluated for a construction worker, for a trespasser/visitor and the resident, since future exposures are expected to be equal or less than current exposures.

E. Surface Water Exposure

Current exposure to surface water was anticipated only for the trespasser/visitor, insofar as that person may come from nearby resident population. Warning signs are posted along the creek, but access restrictions are not in place in all off-site areas. For off-site residents, the trespasser/visitor scenario is assumed to be protective of nearby residents, and it is likely to reflect the actual situation where members of the local population may, from time to time, go into the ditch/creek areas. This was confirmed by recent survey information provided by the Florida Department of Health.

7.3 Toxicity Assessment

Toxicity values are used in conjunction with the results of the exposure assessment to characterize Site risk. EPA has developed critical toxicity values for carcinogens and noncarcinogens. Cancer slope factors (CSFs) have been developed for estimating excess lifetime cancer risks associated with exposure to potentially carcinogenic chemicals. CSFs, which are expressed in units of $(\text{mg/kg/day})^{-1}$, are multiplied by the estimated intake of a potential carcinogen, in mg/kg/day, to provide an upper-bound estimate of the excess lifetime cancer risk associated with exposure at that intake level. The term "upper bound" reflects the conservative estimate of the risks calculated from the CSF. Use of this conservative approach makes underestimation of the actual cancer risk highly unlikely. CSFs are derived from the results of human epidemiological studies or chronic animal bioassays to which animal-to-human extrapolation and uncertainty factors have been applied.

Reference doses (RfDs) have been developed by EPA for indicating the potential for adverse health effects from exposure to chemicals exhibiting noncarcinogenic effects. RfDs, which are expressed in units of mg/kg/day, are estimates of lifetime daily exposure levels for humans, including sensitive individuals. Estimated intakes of chemicals from environmental media can be compared to the RfD. RfDs are derived from human epidemiological studies or animal studies to which uncertainty factors have been applied (e.g., to account for the use of animal data to predict effects on humans). These uncertainty factors help ensure that the RfDs will not underestimate the potential for adverse noncarcinogenic effects to occur.

Quantitative dose-response data were compiled from EPA's Integrated Risk Information System (IRIS), Health Effects Assessment Summary Tables (HEAST), and National Center for Environmental Assessment (NCEA). Toxicity criteria were available for all COPCs except lead. There is no reference dose for lead so the risk characterization was developed by using EPA approved methods for estimating blood lead levels.

The EPA Integrated Exposure Uptake Biokinetic (IEUBK) Model Version 0.99d and the EPA Adult Blood Lead Model are considered applicable at residential and industrial sites, respectively. The IEUBK

was used to evaluate on-Site surface soil, off-site surface soil and off-site sediments. There is currently no lead exposure model available for surface water, the only other medium in which lead was identified as a COPC. In any event, the maximum detected lead concentration in surface water exceeded the drinking water standard of 15ug/L in only 2 out of 16 samples. The IEUBK, which was run with the mean detected concentration of lead in on-Site surface soil (75 mg/kg), off-site surface soil (74 mg/kg) and off-site sediments (22 mg/kg), did not result in a nominal projected blood level above 10 ug/dL for any age group. Based on this analysis, lead was eliminated as a COC for on-Site surface soil, off-site surface soil and off-site sediments.

The US EPA Adult Lead Model was used to develop a target lead concentration for off-site subsurface soil, the only case in which childhood exposure is precluded. The Adult Lead Model results in an off-site subsurface soil concentration of 1,067 mg/kg. The applicable receptor for off-site subsurface soil is the pregnant adult construction worker. It should be noted that the construction worker is applicable for on-Site surface soil as well.

The methodology and the specific model parameters that were used to calculate the adult, nonresidential human health-based target for lead in off-site subsurface soil was developed by the US EPA Technical Review Workgroup (TRW) for Lead and was presented in the report entitled Recommendation of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil. The method is the product of a extensive evaluations by the TRW.

The method used for the adult worker is found in the "Technical Review Workgroup for Lead Recommendations for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil." The calculations for lead soil levels can be found in Appendix C along with the non-cancer toxicity data and cancer toxicity data.

7.4 Risk Characterization

Human health risks are characterized for potential carcinogenic and noncarcinogenic effects by combining exposure and toxicity information. Excessive lifetime cancer risks are determined by multiplying the estimated daily intake level with the CSF. These risks are probabilities that are generally expressed in scientific notation (e.g., 1×10^{-6}). An excess lifetime cancer risk of 1×10^{-6} indicates that, as a plausible upper boundary, an individual has a one in one million additional (above their normal risk) chance of developing cancer as a result of site-related exposure to a carcinogen over a 70-year lifetime under the assumed specific exposure conditions at a Site.

EPA considers individual excess cancer risks in the range of 1×10^{-6} to 1×10^{-6} as protective; however, the 1×10^{-6} risk level is generally used as the point of departure for setting cleanup levels at Superfund sites. EPA's definition of acceptable risk is found in 40 CFR 300.430 (e)(2). The point of departure risk level of 1×10^{-6} expresses EPA's preference for remedial actions that result in risks at the more protective end of the risk range. The health-based risk levels for the Site in its current condition are shown in Tables 10.1 through 10.7 in Appendix C.

Potential concern for noncarcinogenic effects of a single contaminant in a single medium is expressed as the hazard quotient (HQ) (or the ratio of the estimated intake derived from the contaminant

concentration in a given medium to the contaminants' reference dose). An HQ which exceeds unity (1) indicates that the daily intake from a scenario exceeds the chemical's reference dose. By adding the HQs for all contaminants within a medium or across all media to which a given population may reasonably be exposed, the Hazard Index (HI) can be generated. The HI provides a useful reference point for gauging the potential significance of multiple contaminant exposures within a single medium or across media. An HI which exceeds unity indicates that there may be a concern for potential health effects resulting from the cumulative exposure to multiple contaminants within a single medium or across media. The HIs for the Site are shown in Tables 10.1 through 10.7 in Appendix C.

Using the results of the human exposure assessment and the toxicity information, potential human health risks for each COPC and selected exposure pathway were evaluated. Upper bound excess lifetime cancer risks for carcinogenic chemicals and hazard quotients and hazard index values for noncarcinogenic chemicals were estimated. The upper-bound lifetime excess cancer risks derived in this report can be compared to EPA's target risk range for health protectiveness at Superfund sites of 1×10^{-6} to 1×10^{-4} . In addition, the noncarcinogenic hazard indices can be compared to a value of 1 since hazard indices greater than 1 indicate a potential for adverse health effects.

The risk characterization results showed unacceptable risks (i.e., upper-bound excess lifetime cancer risks exceeding the upper limit of EPA's target risk range for health protectiveness at Superfund sites [1×10^{-4}] and/or non-cancer hazard indexes (HIs) greater than one) in surface soil and groundwater. However, it should be noted that exposures to groundwater at the SGP Site are not likely to occur because water is supplied to the area by a municipality.

A summary of potential cancer risk and non-cancer hazard estimates resulting from exposures to Site COCs in surface soil, subsurface soil, surface water, and/or sediment by residents, commercial workers, construction workers, and trespassers/visitors are provided in Appendix C.

7.5 Environmental Risk

An Ecological Risk Assessment (ERA) for all media will be completed as part of OU3 which will address the sediments in the Cloud Branch Creek. Recent OU1 Compendium submittal and review demonstrated that no environmental COPCs were to be retained for the OU1 soil cleanup and no confirmation samples were to be required after OU1 removal is completed. Further environmental assessment is needed for Cloud Branch Creek and the delta area where Cloud Branch Creek discharges into Lake Monroe. A copy of the ERA Compendium could be found in the OU2 AR and a copy of the March 5, 2001 letter accepting the report is attached in Appendix E of this ROD.

7.6 Risk Uncertainty

There are uncertainties which are inherent in the risk assessment process. The calculations and conclusions which are presented in the BRA report include uncertainties which may arise from assumptions used in several steps of the assessment. The factors which may lead to either overestimation or an underestimation of the potential adverse effects and associated environmental risks posed by exposure to analytes at the former Sanford facility, depending on the relationship of actual conditions to assumptions employed in the calculations, include the following:

- the analytical data presented here may, not reflect actual site conditions for all analytes at the present time. Data has been collected during several years of the former facility investigations. However, concentrations in other areas are not expected to be higher than the values presented in the report because the site equipment has been dismantled, activities have ceased, and no new sources have been added. It is expected that the concentrations presented in the report may actually overestimate the true exposure conditions in the future due to processes such as biodegradation and dilution;
- assumptions regarding, for example, body, weight, average human lifetime, and other factors were based on reasonable estimates from available sources and may not be accurate for specific individuals whose characteristics may vary from the conservative general conditions which were assumed. However, standard assumptions were employed in those cases where they were available and professional judgment was applied elsewhere. The report includes references to all values used;
- uncertainties associated with the assumptions have been made regarding the future land use and groundwater use at the former facility. What is known about expected land use and groundwater use at the former facility is reflected in these exposure assumptions. However, should either the expected land use or groundwater use change, the uncertainty of the conclusion would be increased;
- factors which affect the disposition of absorbed site contaminants, such as metabolism, distribution, bioconcentration and excretion, were not explicitly considered in detail in the intake and risk calculations. Rather, reasonable and conservative assumptions were employed which are unlikely to underestimate the true exposure conditions;
- the mechanism of action for toxicity of the site contaminants is not known with certainty in many cases, particularly regarding their putative carcinogenic effects. The rather specific nature of the carcinogenic effects in animal studies suggests that any extrapolation to humans will be heavily dependent on the assumption which often is not supported by the epidemiological data. This uncertainty is reflected in the recent reevaluation of U.S. EPA approaches to carcinogen assessment. Consistent with standard risk assessment practice, the US EPA Reference Doses (RfDs) and Cancer Slope Factors (CSFs) were used to reflect toxicity endpoints of interest;
- non-quantifiable uncertainties are inherent in several different aspects of the exposure variables and the estimation of potential human health effects and intake risk calculations. Extrapolation of dose-response curves from high to low dose, from animals to humans and from one exposure route to another introduce uncertainty, intended to be conservative, at each step in the calculated results. The use in the report of established Unit Cancer Risk values (i.e., Carcinogenic Slope Factors) which have been calculated by ostensibly conservative methods (e.g., the linearize multistage model) is unlikely to underestimate the true risk and may overestimate it by a margin which is not quantifiable at present; and;
- the intake and risk calculations assume that the exposure conditions can be represented by a deterministic approach which views each variable separately and may result in inappropriate targets if conservative assumptions are "layered" on top of one another. Probabilistic methods are available for such evaluations, but were not employed in this stage of the risk assessment activities.

8.0 REMEDIATION OBJECTIVES

EPA developed a range of alternatives to address the contamination at the Site. The alternatives were based upon the following OU2 remedial action objectives:

- To reduce COCs in groundwater to Applicable or Relevant and Appropriate Requirements (ARARs) or health-based levels where ARARs are not available.

The cleanup goals for the Site were developed specifically to protect human health and to address the risk identified in the Human Health Risk Assessment. These goals are based on available information, standards such as Applicable or Relevant and Appropriate Requirements (ARARs) and the risk-based levels (Remedial Goal Options).

8.1 Subsurface Soil Goals

EPA developed alternative soil remedial goals for subsurface contamination which could contribute to groundwater contamination through soil contaminant leaching. The alternative soil remedial goals are consistent with the planned "hot-spot" subsurface soil remedial approach for the OU1 which were developed for direct exposure.

Since there is no MCL value for naphthalene, a risk-based value had to be used to verify soil goals from OU1 are protective of groundwater. The BRA did not include a Remedial Goal Option (RGO) for naphthalene based on residential use of groundwater as a drinking water source. Therefore, the EPA Region 4 Office of Technical Services suggested the use of the "Drinking Water Standards and Health Advisories." The EPA's Office of Water updated the "Drinking Water Standards and Health Advisories" report in Summer of 2000, affecting any cleanup standards previously calculated. The Sanford PRP Group also proposed a change in the organic carbon partitioning coefficient (K_{oc}) for naphthalene. After careful consideration, EPA accepted the change and a new soil remedial goal that would be protective of groundwater was calculated to be 3 mg/kg. Also, this number was used to calculate the groundwater remedial goal option appearing in the September 28, 2000 revision to the OU2 FS report.

Based on EPA's calculations, a naphthalene remedial goal objective of 3 mg/kg will not cause a significant change in the soil area to be removed under previous calculations from the final OU1 FS report. Thus, there will not be a change with respect to the scope of the remedial action as it pertains to the soil area. This new remedial goal essentially involves contaminated soils that will likely be either remediated to address other soil contaminants that represent a potential or actual threat to groundwater, or that would be termed as the "source", based on visual evidence of contamination, and thus targeted for the remedial action. More importantly, it is not expected that this change will affect the previous cost estimate for the OU1 remedial action. All information reflecting this evaluation is documented in the January 17th, 2001 memo to the file included in the AR for OU2.

Cleanup goals for the sub-surface soil contamination, of those contaminants that potentially posed an adverse effect on groundwater quality, have been determined for benzene, naphthalene, ethylbenzene and total xylenes. Subsurface soils remedial goals for benzene, ethylbenzene and total xylenes are based on protection for the respective MCLs. Remedial goal for naphthalene is based on protection from groundwater

consumption which exceeds the lifetime health advisory. As referenced in OU1 FS Addendum, EPA considers the following as appropriate soil remedial goals for groundwater protection applicable to the Sanford Site.

TABLE 6: REMEDIAL GOALS FOR SUBSURFACE SOIL BASED ON PROTECTION TO GROUNDWATER	
CONTAMINANT	GOAL (mg/kg)
Benzene	0.05
Naphthalene	3**
Ethylbenzene	12
Total Xylenes	43

** surface and subsurface soil cleanup goal

8.2 Groundwater Remedial Goals

EPA developed remedial goals for the groundwater contamination to be consistent with the remedy selected. The remedial goal value for naphthalene is consistent with the approach on selecting the remedial goal value for soil protection to groundwater cleanup on OU1. No groundwater cleanup goal was calculated for total xylenes since its MCL value is 10,000 ug/L and the maximum value found in sample results was 310 ug/L. All information related to the remedial goal selection is documented in the January 17th, 2001 memo to the file included in the AR for OU2.

TABLE 7: REMEDIAL GOALS FOR GROUNDWATER			
Contaminant	Clean up Goals (ug/L)	Frequency of Detection (ug/L)	Maximum Concentration Detected (ug/L)
Benzene	1 ¹	5/37	2,000
Naphthalene	100 ²	14/37	11,000
Ethylbenzene	700 ³	9/37	1,400

1 State Maximum Contaminant Level (FL MCL) for Drinking Water

2 Risk-based Goal, Lifetime Health Advisory. January 17th, 2001 memo to the file in the OU2 AR

3 Federal Maximum Contaminant Level(MCL) for Drinking Water

9.0 SUMMARY OF ALTERNATIVES

In considering OU2 (groundwater) RAOs, the analysis presented below reflects the fundamental components of the various alternatives developed to address it.

SUMMARY OF CLEAN UP ALTERNATIVES

Cleanup options were developed in the FS report approved in December 21, 2000. This Section of the ROD presents possible groundwater cleanup remedies for the SGP Site. A detailed presentation of each of the alternatives is in the FS Report for OU2.

Alternative 1: No Action

Under the no action alternative, the site is left "as is" and no funds are expended to actively control or cleanup the site related contamination. No remedial action would be taken. No funds will be expended to monitor the Site groundwater.

Annual Operation and Maintenance (O&M):	\$0
Present Worth:	\$0

Alternative 2: Institutional Controls

Under this alternative, institutional controls would be implemented to reduce the potential risk associated with the exposure to the groundwater impacts. Institutional controls would include: the formation of a Groundwater Use Advisory Zone (GUAZ) which would include properties that may be affected by the shallow groundwater impacts at the Site. The GUAZ is shown in Appendix F, which is a property ownership map and includes only the five property owners as identified by Seminole County Tax Panel. Property owners are: FPUC, City of Sanford, CSX Transportation, Inc., Christian Transportation, Inc., and Codisco, Inc. Property addresses could be found in the December 4, 2000 response to EPA comments prepared by GEI Consultants as part of the OU2 FS deliverable, included in the OU2 AR. Property owners within the GUAZ will be notified by EPA, in writing, of the potential risk associated with exposure to contaminated groundwater. The notification will include a map showing the location of the contaminated groundwater plume and will advise them not to install groundwater wells near the plume. The notice will also include an EPA point of contact for any questions regarding the advisory. Annual cleanup updates will be sent to property owners within the GUAZ informing them of groundwater plume conditions and reminding them of the groundwater advisory.

Annual Operation and Maintenance (O&M):	\$1,500
Present Worth:	\$51,504

Alternative 3: Monitored Natural Attenuation

Under this alternative the natural attenuation of groundwater contamination would be monitored by groundwater sample collection from designated wells. In addition to existing wells, new wells would be constructed after OUI Remedial Action is completed. All wells would be used to monitor geochemical

indicators of natural attenuation, field parameters and contaminants of concern. It is expected that the groundwater attenuation process will take approximately 33 years.

In addition to the monitoring, this alternative will include the implementation of institutional controls as described in Alternative 2.

Natural attenuation process includes a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil or groundwater. These in situ processes include: biodegradation, dispersion, dilution, sorption, volatilization, radioactive decay, and chemical or biological stabilization, transformation, or destruction of contaminants. Groundwater monitoring is a critical component of this remedy to ensure the remedy is protective and natural processes are reducing contamination levels as expected.

Annual Operation and Maintenance (O&M):	\$24,004
Present Worth:	\$320,252

Alternative 4: Air Sparge and Soil Vapor Extraction

This alternative would enhance biodegradation and volatilization of impacts in the subsurface by the addition of air. Air would be injected in the subsurface and would be recovered by a vacuum system. To ensure effectiveness of the remedy a pilot test would be designed. It is expected this alternative would take approximately 17 years to clean groundwater up to clean up goals.

Annual Operation and Maintenance (O&M):	\$81,250
Present Worth:	\$854,386

Alternative 5: Groundwater Pump and Treat

This alternative would involve pumping and treating groundwater downgradient from soils removed as part of OU1 area (former Sanford Gasification plant Site up to the confluence of the unnamed tributary and Cloud Branch Creek(see Figure 3)). Approximately six recovery wells would be used to recover impacted groundwater. Then, groundwater would be discharged to the City of Sanford Waste Water Treatment Plant for treatment. A pilot test would be necessary to select the number and location of recovery wells and to determine the groundwater recovery rate. It is expected this alternative would take approximately 24 years to clean groundwater up to cleanup goals.

Annual Operation and Maintenance (O&M):	\$141,885
Present Worth:	\$1,785,236

10.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

EPA has established nine criteria which are used in comparing the advantages and disadvantages of each alternative.

The alternatives are evaluated against one another by using the following nine criteria:

- Overall protection of human health and the environment
- Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)
- Long term effectiveness and permanence
- Reduction of toxicity, mobility, or volume through treatment
- Short term effectiveness
- Implementability
- Costs
- State Acceptance
- Community Acceptance

The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) categorized the nine criteria into three groups:

- (1) Threshold criteria: the first two criteria, overall protection of human health and the environment and compliance with ARARs (or invoking a waiver), are the minimum criteria that must be met in order for an alternative to be eligible for selection
- (2) Primary balancing criteria: the next five criteria are considered primary balancing criteria and are used to weigh major trade-offs among alternative cleanup methods
- (3) Modifying criteria: state and community acceptance are modifying criteria that are formally taken into account after public comment is received on the proposed plan. Community acceptance is addressed in the responsiveness summary of the ROD.

10.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment addresses whether each alternative provides adequate protection of human health and the environment and describes how risks posed through each exposure pathway are eliminated, reduced, or controlled, through treatment, engineering controls, and/or institutional controls.

Alternative 1, No Action, would not be protective of human health, therefore it is eliminated from further consideration. Alternative 2 would reduce the level of risk through Institutional Controls. Alternative 3, Monitored Natural Attenuation, would, over time, reduce contaminant concentrations to levels protective of human health and the environment. Alternatives 4 and 5 would remove contamination from the groundwater via extraction and treatment. Alternatives 3, 4 and 5 would be more protective than Alternative 2, since each alternative would reach the proposed cleanup goals. Alternative 2 may not reach proposed cleanup goals in a reasonable time period.

10.2 Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)

Section 121(d) of CERCLA requires that remedial actions at CERCLA sites attain legally applicable or relevant and appropriate Federal and State requirements, standards, criteria, and limitations which are collectively referred to as "ARARs", unless such ARARs are waived under CERCLA section 121(d)(4).

Applicable requirements are those cleanup standards, standards of control, and other substantive requirements, criteria or limitations promulgated under Federal environmental or State environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive requirements, criteria or limitations promulgated under Federal environmental or State environmental or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site address problems or situations sufficiently similar to those encountered at the Site and that their use is well suited to the particular site.

Alternative 2 could not be designed to attain ARARs and only would provide protection through restricted use rather than restoration measures. Therefore, Alternative 2 is eliminated from further consideration. Alternatives 3, 4 and 5 could be designed to attain ARARs and all of them have ARARs associated with drinking water standards. Alternative 3 would limit exposure to groundwater, through Institutional Controls, until MCLs are attained.

10.3 Long-Term Effectiveness and Permanence

Long-term effectiveness and permanence refers to the expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup levels have been met. This criterion includes the consideration of residual risk that will remain onsite following remediation and the adequacy and reliability of controls.

Alternatives 3, 4 and 5 are all effective and permanent remedies, however time to achieve remedial goals for the groundwater cleanup will vary. Alternatives 4 and 5 involve active remedies to achieve cleanup goals, while Alternative 3 passively addresses the groundwater contamination through natural attenuation. Institutional Controls in Alternative 3 would reduce health risks associated with consumption of groundwater, however groundwater in the area of the former facility is not used as a drinking water source since there is community-supplied water. Alternatives 4 and 5 would take less time to achieve the remedial goals.

10.4 Reduction of Toxicity, Mobility, or Volume

Reduction of toxicity, mobility, or volume through treatment refers to the anticipated performance of the treatment technologies that may be included as part of the remedy.

Alternative 3 relies on natural attenuation rather than an active remedy to achieve remedial goals. Alternatives 4 and 5 would provide comparable reductions in the toxicity, mobility, and volume of ground-water contamination at the Site with active remedies. All of the alternatives could be designed to reduce the toxicity, mobility or volume, though they will be achieved in different lengths of time.

10.5 Short-Term Effectiveness

Short-term effectiveness addresses the period of time needed to implement the remedy and any adverse impacts that may be posed to workers, the community and the environment during construction and operation of the remedy until cleanup levels are achieved.

All of the alternatives would require workers to use Level D protective equipment during implementation of the remedies.

Alternative 4 and 5 would both require more time for design and construction groundwater treatment. Workers on Alternative 3 would not have the same level of exposure than under construction and implementation of Alternatives 4 and 5. Only the construction of four (4) new wells would be required and then groundwater sample collection until remedial goals are attained. A treatment system could produce additional noise or nuisance problems. Alternative 4 would provide the most short-term effectiveness, since it will reach remedial goals sooner than the other alternatives.

10.6 Implementability

Implementability addresses the technical and administrative feasibility of a remedy from design through construction and operation. Factors such as availability of services and materials, administrative feasibility, and coordination with other government entities are also considered.

All necessary equipment and materials are commercially available for implementation of Alternatives 3, 4 and 5. Alternatives 4 and 5 are considered more difficult to implement than Alternative 3, because they would require more time to design and construct. Pilot-scale studies would be required and a number of engineering considerations would be required in the development of the groundwater extraction and treatment. Alternatives 4 and 5 utilize technology that is well established but requires operator attention on a daily basis. Alternative 3 would be the most implementable as it involves only the construction of four (4) wells and regularly scheduled monitoring events during the 33 years. Alternative 5 requires the most significant construction activities to build treatment system.

10.7 Cost

A summary of the present worth, capital, and operation and maintenance (O&M) costs for each of the alternatives is presented in Table 8. Alternative 5 is the most expensive alternative. Alternative 3 is the least expensive. Itemized costs for each alternative could be found in Appendix D.

TABLE 8: COST COMPARISON OF REMEDIAL ALTERNATIVES					
	Alternative 1 No Action	Alternative 2 Institutional Controls	Alternative 3 Monitored Natural Attenuation	Alternative 4 Air Sparge and Soil Vapor Extraction	Alternative 5 Ground water Pump and Treat
Capital Cost	\$0	\$37,500	\$37,500	\$326,563	\$243,750
Annual O&M	\$0	\$1,500	\$24,004	\$81,250	\$141,885
Present Worth Total Cost	\$0	\$61,504	\$320,252	\$854,386	\$1,785,236

10.8 State Acceptance

In accordance with 40 CFR 300.430, the State of Florida has been involved in the process and the State has not opposed the remedy selected.

10.9 Community Acceptance

EPA held a public meeting to discuss the proposed remedy on February 7, 2001. No comments from the community were received during the comment period or during the public meeting. EPA received only one concern from the Sanford PRP Group, regarding ecological issues for the soils cleanup. EPA's response and actions regarding their concern could be found in the Responsiveness Summary, in Appendix B. No opposition regarding the remedy selection was received by any parties.

11.0 PRINCIPAL THREAT WASTES

The NCP establishes an expectation that EPA will use treatment to address the principal threats posed by the Site wherever practicable (NCP 300.430 (a)(1)(iii)(A)). The "principal threat" concept is applied to the characterization of "source materials" at a Superfund site. A source material is material that includes or contains hazardous substances, pollutants or contaminants that act as a reservoir for migration of contaminants to groundwater, surface water or air, or acts as a source for direct exposure. Contaminated groundwater generally is not considered to be a source material.

After the removal of surface soils and subsurface soils the "source material" at the Site will be non-existent. This remedial action is selected to address residual groundwater contamination that may be left on Site after the removal action.

12.0 SELECTED REMEDY

12.1 Rationale for the Selected Remedy

Based upon consideration of the requirements of CERCLA, the NCP, the detailed analysis of alternatives and public and state comments, EPA has selected Alternative 3: Monitored Natural Attenuation With Institutional Controls. Under this alternative, it is expected groundwater contamination will naturally attenuate to reach groundwater remedial goals within 33 years. Following implementation of the removal of surface soils and subsurface "hot spot" areas, further groundwater sampling is expected to demonstrate a significant decrease of groundwater contamination in the outlined area (see Figure 4). Five (5) existing wells in addition to four (4) new wells will be used to monitor groundwater remediation following implementation of OU1 remedy.

This remedy is selected because it is protective of human health and the environment and complies with all ARARs. It represents the best balance among tradeoffs with respect to the Primary Balancing Criteria. This remedy will reduce risk and prevent exposure to contaminated groundwater through Institutional Controls. Natural processes will decrease contaminant concentrations over time, and these concentrations can be monitored and evaluated periodically to ensure that the remedy remains protective. This remedy is easily implementable because it builds upon an existing monitoring well network. This alternative is also selected because it is significantly cheaper than the groundwater extraction and treatment alternatives. Operation of a groundwater extraction and treatment system is not guaranteed to achieve remedial goals in an efficient manner and would not provide a significantly greater degree of protectiveness of human health and the environment. Monitored Natural Attenuation with Institutional Controls is the most appropriate remedy because it is protective of human health and the environment and it allows EPA to monitor and evaluate the contaminant plume to continually verify the remedy's effectiveness given the specific site characteristics. The present worth cost of the remedy is \$320,252.00.

12.2 Description of the Remedy

Natural attenuation process includes a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil or groundwater. These in situ processes include: biodegradation, dispersion, dilution, sorption, volatilization, radioactive decay, and chemical or biological stabilization, transformation, or destruction of contaminants. Groundwater monitoring is a critical component of this remedy to ensure the remedy is protective and natural processes are reducing contamination levels as expected.

A mathematical model has been used to estimate the time that groundwater contamination would be effectively remediated through natural attenuation processes. The model, presented in Appendix A, estimated that RGOs would be achieved in 33 years by natural attenuation. It is assumed that samples will be collected from five (5) existing wells (Q-3, MW-11S, MW-11I, MW-21S and MW-21I) and four (4) new wells. The existing well locations are illustrated in Figure 3. The exact number and location of additional wells will be determined after considering the data collected during and after implementation of OU1 remedy. New wells will be installed following implementation of OU1 remedy. Sampling frequency will be re-evaluated after consideration of data from each sampling event. For cost estimating purposes, a total of

22 sampling events will be conducted; one per year during the first five(5) and last five (5) years of this remedial action, and every other year in between. Sampling parameters and frequency of analysis will also be re-evaluated after consideration of data from each sampling event. For costing purposes it is assumed that BTEX and PAHs will be collected and analyzed during every sampling event, along with the field parameters listed in Table 9 will be collected and analyzed three (3) times in the first five (5) years. The model will be calibrated with new data and the time to achieve RGOs will be estimated and discussed after each sampling event. This alternative may also require a statistical analysis of the data to determine that groundwater concentration have achieved RGOs. This alternative also has a provision for re-evaluating engineered remedial actions if data indicate that an evaluation is warranted.

Under this alternative institutional controls would be implemented to reduce the potential risk associated with the exposure to the groundwater impacts. Institutional Controls would include: restricting unauthorized excavation on property above impacted groundwater and restricting the installations of groundwater wells. A Groundwater Use Advisory Zone (GUAZ) will be created that includes properties that may be affected by the shallow groundwater impacts at the Site. The GUAZ is shown in Appendix F, which is a property ownership map and includes only the five property owners as identified by Seminole County Tax Panel. Property owners are: FPUC, City of Sanford, CSX Transportation, Inc., Christian Transportation, Inc., and Codisco, Inc. Property addresses could be found in the December 4, 2000 response to EPA comments prepared by GEI Consultants as part of the OU2 FS deliverable, included in the OU2 AR. The annual inspection to observe and document site conditions would be conducted by EPA to confirm compliance with controls.

TABLE 9: SAMPLING PARAMETERS FOR NATURAL MONITORED ATTENUATION
PARAMETERS
Field Parameters
PH
Temperature
Dissolved Oxygen
Oxidation Reduction Potential
Conductivity
Field Alkalinity
Filtered Iron (Dissolved iron)
Geochemical Parameters
Non-Filtered Iron (Total Iron)
Filtered and Non-Filtered Manganese
Nitrate
Nitrite

Ammonia nitrogen
Sulfate
Sulfite
Sulfide
Total Organic Carbon
Total Alkalinity
Contaminants and By-Products
Volatile Aromatic Hydrocarbons
Polynuclear Aromatic Hydrocarbons
Dissolved Methane, Ethane and Ethene

12.3 Summary of the Estimated Remedy Costs

The information in the cost estimate summary in Table 8 is based on the best available information regarding the anticipated scope of the selected remedy. Changes in the cost elements are likely to occur as a result of new information and data collected during the post-ROD sampling. Major changes may be documented in the form of a memorandum to the Administrative Record file, an Explanation of Significant Differences or a ROD Amendment. This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost. The total present worth cost is \$320,000. See Appendix D for full itemization of estimated cost.

12.3 Expected Outcome of Selected Remedy

The purpose of this action is to reduce the potential for direct exposure to contaminated groundwater for future residents and commercial workers by reducing COCs in groundwater to Applicable or Relevant and Appropriate Requirements (ARARs) or health-based levels where ARARs are not available. The groundwater remedial goals on Table 10 will be the cleanup goals for the implementation of the selected remedy.

TABLE 10: CLEANUP LEVELS FOR CHEMICALS OF CONCERN		
Chemical of Concern	Cleanup Level (ug/L)	Basis of Cleanup Level
Benzene	1	FL Maximum Contaminant Level
Naphthalene	100	Lifetime Health Advisory
Ethylbenzene	700	Federal Maximum Contaminant Level

13.0 STATUTORY DETERMINATIONS

EPA has determined that the selected remedy will satisfy the statutory determinations of Section 121 of CERCLA. The remedy will be protective of human health and the environment, will comply with ARARs, will be cost effective, and will use permanent solutions and alternative treatment technologies to the maximum extent practicable.

13.1 Protection of Human Health and the Environment

The remedy will eliminate the potential risks for future residents and commercial workers from exposure to contaminated groundwater. The groundwater contaminants will naturally degrade and/or attenuate to levels to comply with groundwater cleanup levels. There are no private wells located in the area of groundwater contamination.

13.2 Compliance with ARARs

The selected remedy will comply with the substantive requirements of Federal ARARs and State ARARs listed in the table below.

TABLE 11: ARARS		
LOCATION SPECIFIC		
	Citation	Location/Description
A	Areas of known contamination. Regulatory clearance required to use potable water wells area of known contamination	Chapter 62-524, FAC
B	Hazardous waste sites. Requires use of warning signs to inform public of potentially harmful conditions at sites.	Chapter 62-730.1 80, FAC
CHEMICAL SPECIFIC		
A	Groundwater, Classes and Exemptions	Chapter 62-520.420, FAC
B	Drinking Water Standards	Chapter 62-550.310 and 550.320, FAC
C	Federal Drinking Water Standard Maximum Contaminant Levels	40 CFR 141.61 and 141.62
ACTION SPECIFIC		
A	Occupational Safety and Health Administration (OSHA) Standards for Hazardous Materials Response	29 CFR 1904, 1910 and 1926

13.3 Cost Effectiveness

In EPA's judgement, the selected remedy is cost effective and represents a reasonable value for the money. The following definition was used in making this determination: "A remedy shall be cost effective if its costs are proportional to its overall effectiveness." (40 CFR 300.430(f)(1)(ii)(D)). This was accomplished by evaluating the "overall effectiveness" of those alternatives that satisfied the threshold criteria (i.e., were both protective of human health and the environment and ARAR-compliant). Overall effectiveness was evaluated by assessing three of the five balancing criteria in combination: long term effectiveness and permanence, reduction in toxicity, mobility, and volume through treatment, and short term effectiveness. Overall effectiveness was then compared to costs to determine cost effectiveness.

The selected remedy, Alternative 3, is a cost effective remedy. The selected remedy includes natural attenuation and monitoring. The effectiveness of the remedy will be evaluated by EPA during the Five Year Review evaluation conducted after a remedy has been implemented. The total estimated present worth cost of this alternative is approximately \$320,000 which includes capital costs and annual operation and maintenance costs. EPA has determined that the cost of implementing the remedy is proportionate to the overall effectiveness of the remedy and is a reasonable value.

13.4 Utilization of Permanent Solutions or alternative treatment technologies to the maximum extent practicable

The selected remedy uses permanent solutions and treatment technologies to the maximum extent practicable. Natural attenuation is expected to permanently achieve the groundwater cleanup standards within 33 years.

13.5 Preference for Treatment

Natural attenuation has been identified as occurring at the Site, resulting in *in-situ* treatment of contaminants leading to a reduction in the toxicity, mobility and volume of contaminants. Moreover, following implementation of the removal of surface soils and subsurface soils, further groundwater sampling is expected to demonstrate a significant decrease of groundwater contamination in the outlined area. While natural attenuation in some cases, is not preferred, because of the statutory preference for *in-situ* treatment, it is more than suitable in this circumstance because natural attenuation is resulting in a reduction of contaminants.

The model for groundwater attenuation will be calibrated with new data at that time. It is possible that sampling data may demonstrate that groundwater could attenuate prior to 33 years. Additionally, groundwater in the delineated area is not used as a drinking water source since there is community-supplied water, and institutional controls will be included as part of the remedy selection. The benefits of selecting one of the treatment alternatives are not significant enough to offset the substantial added cost.

13.6 Five-Year Review Requirements

The effectiveness of the remedy will be evaluated by EPA during the Five Year Review evaluation conducted after a remedy has been implemented. The evaluation of the remedy should determine if natural

attenuation is occurring in accordance to the expectations. Monitoring frequencies may be adjusted depending on the progress of the natural attenuation remedy. Monitoring should continue until remediation goals are achieved. If a review of the effectiveness of the remedy indicates that it is not effective in either remediating the groundwater or preventing further significant expansion of groundwater contamination, the remedy could potentially be modified to include an active remedial measure.

14.0 EXPLANATION OF SIGNIFICANT CHANGES

The remedy described in this ROD is the preferred alternative described in the Proposed Plan for this Site. There have been no significant changes in the selected remedy.

APPENDIX A: GROUND WATER MODELING RESULTS

APPENDIX A

GROUNDWATER MODELING RESULTS

A groundwater flow and transport model was developed to evaluate the timeframe for groundwater impacts to attain RGOs through natural attenuation processes and using engineered alternatives. The groundwater transport model was developed using Visual MODFLOW™ (version 2.8.2, Waterloo Hydrogeologic Software, Inc., Waterloo, Ontario, Canada). Visual MODFLOW™ is a pre-and post-processor for MODFLOW™ (McDonald and Harbaugh, 1988) and MT3D (Zheng, 1991). MODFLOW™ is a three-dimensional computer model developed for the United States Geological Society (USGS), which uses a block-centered finite-difference scheme to solve the three-dimensional groundwater flow equation. MT3D is a computer model developed through the United States Department of Defense for simulation of advection, dispersion, and chemical reactions of contaminants in groundwater in either two or three dimensions. Visual MODFLOW™ incorporates the latest versions (MODFLOW96 and MT3D99) of these computer models.

Visual MODFLOW™ was used to develop a two-dimensional model to estimate concentrations of compounds of concern in groundwater along the presumed centerline of the plume after source removal (remedial action for OU1) at the Sanford Gasification Plant Site. Specifically, dissolved benzene and naphthalene concentrations were modeled. Visual MODFLOW was selected instead of less complex two-dimensional models like BIOSCREEN and BIOPLUME for the following reasons.

- The model can simulate adsorption, dispersion, and biodegradation transport processes.
- The model can simulate the instantaneous removal of the groundwater source.

Although visual MODFLOW is a powerful numerical tool, the limited data available for calibrating the site model results in more of a qualitative evaluation of the timeframe for groundwater impacts to attenuate to RGOs rather than a quantitative evaluation. Specifically, there is only one downgradient data point available for calibrating the benzene transport model. A variety of combinations of model inputs could simulate the measured downgradient concentration. This model, developed to simulate the conditions at the Facility, uses input parameters derived from site specific information, literature values, and model calibration. A sensitivity analysis of the model to the various input parameters was performed. Based on the model calibration and the sensitivity analysis, this model provides a realistic simulation of the groundwater system at the Facility. Details regarding model input parameters and sensitivity analyses are presented in subsequent sections of this appendix.

For the Sanford Gasification Plant site, the following general assumptions were used to develop the groundwater transport model.

- Groundwater flow occurs under steady-state conditions.
- Groundwater discharges to Lake Monroe (simulated as a constant head boundary).
- Fate and transport processes remain constant over time.
- The source was in place since 1880 (initiation of plant operations).
- The groundwater source concentration of benzene and naphthalene are constant from 1880 to 2000..
- Equilibrium sorption is modeled using a linear isotherm.
- Biological decay is modeled using a first order rate reaction.
- The source is instantaneously removed after 120 years.
- The benzene and naphthalene concentration at well location MW-21I is at steady state and is used for model calibration.

- The naphthalene concentration at well location MW-1II is at steady state and is used for model calibration.

Groundwater Flow Model Description

Figure A-1 illustrates the model domain. The model domain encompassed an area 5000 feet long by 2000 feet wide and consisted of one layer of variable thickness based on borings completed on site. Figure A-2 illustrates the discretization of the model domain. Grid spacing was approximately 100 feet by 100 feet. The cell size was decreased to 25 feet by 25 feet in the vicinity of the source area to provide a more accurate simulation of contaminant transport.

Figure A-3 presents the boundary conditions for the groundwater flow model. A constant head boundary was defined along the southern boundary with a value of 25 feet above mean sea level (MSL). The constant head boundary was calculated based on measured groundwater elevation data and observed groundwater flow directions. Lake Monroe, located north of the site, was simulated as a constant head boundary with a water elevation of 0.5 feet based on the Sanford USGS topographic map and the surface water elevation of 0.7 feet MSL measured at the Cloud Branch Creek and Mill Creek confluence. Cloud Branch Creek, the unnamed tributary, and Mill Creek were not included in the groundwater flow model since limited information on their hydraulic connection to the aquifer is available. Groundwater at the site appears to discharge directly to the tributary and the Creeks. Therefore, not simulating groundwater discharge to these surface water bodies in the model is a conservative approach to approximating the benzene and naphthalene groundwater concentrations following source removal.

The groundwater flow model was calibrated by varying the hydraulic conductivity values to match the model-predicted groundwater elevations to the groundwater elevations measured on June 4, 1999. Figure A-4 illustrates the model-calibrated horizontal hydraulic conductivity values. The model-calibrated horizontal hydraulic conductivity values for the aquifer range from 10 feet/day to 200 feet/day. The measured horizontal hydraulic conductivity values based on slug tests conducted at the site range from 0.6 feet/day to 7.0 feet/day. Grain size analysis results for soil collected from boring location SB-13I indicate that the hydraulic conductivity ranges from 19 feet/day to 75 feet/day. Based on GEI's experience and comparison of slug test derived hydraulic conductivities and grain-size analysis derived hydraulic conductivities to pump test derived hydraulic conductivities for the shallow aquifer in central Florida, the hydraulic conductivity of the shallow aquifer is more closely represented by the values determined from grain-size analysis than from slug test data. Although some of the calibrated hydraulic conductivity values are higher than the values estimated from grain size analysis, the sensitivity analysis (discussed below) indicates that lower values have little effect on the estimated time for groundwater concentrations to decrease below the RGOs.

The groundwater flow model was calibrated by comparing the model-predicted groundwater elevations to the field-measured groundwater elevations. The groundwater elevations measured in the intermediate monitoring wells were used to calibrate the groundwater flow model since the greatest groundwater impacts were detected within the intermediate interval and they are less affected by the creeks. The monitoring wells used to calibrate the flow model are illustrated in Figure A-5. Figure A-6 shows the groundwater contours based on measured and model-predicted groundwater elevations. Since the surface water bodies are not simulated in the model, the model-predicted groundwater contours are perpendicular to the surface water bodies and groundwater does not discharge directly to the surface water bodies (Figure A-6). Figure A-7 shows a scatter plot of the model-predicted and measured groundwater elevations. In Figure A-7 the straight line represent equal groundwater elevations (i.e., model-predicted groundwater elevation equals the measured groundwater elevation). Figures A-6 and A-7 illustrate that the model-predicted groundwater elevations correlate well with the groundwater elevations measured on June 4, 1999.

Contaminant Transport Model Description

The calibrated groundwater flow model was then used to develop contaminant transport models for benzene and naphthalene migration to predict the sorption coefficient and the biodegradation rate. The contaminant transport models were calibrated by comparing the model-predicted benzene and naphthalene groundwater concentrations to the measured groundwater concentrations obtained during the last groundwater-sampling event (December 1998 and May 1999).

Figure A-8 illustrates the location of the benzene and naphthalene groundwater source simulated in the contaminant transport models. The source area simulated in the model encompasses the three distinct areas where MGP tar or NAPL was observed and where subsurface soils potentially contribute to groundwater impacts in excess of Florida MCLs (areas of soil removal for OU1). For the purpose of determining groundwater source concentrations, the following wells were selected to represent groundwater conditions within the source area: MW-3S, MW-SA-4S, MW-SA-5S, MW-12S, and MW-12I. The simulated benzene groundwater source concentration equals the maximum benzene concentration detected in groundwater collected from the source area in 1998 (2000 ug/L measured at MW-3S). The simulated naphthalene groundwater source concentration equals the maximum naphthalene concentration detected in groundwater collected from the source area in 1998 (3800 ug/L measured at MW-SA-4S). The maximum concentrations were selected and applied over the entire simulated source area to be conservative in the estimated time for groundwater impacts to attenuate to RGOs. The initial groundwater concentrations outside of the source area equal zero.

Due to limited temporal and spatial data, Visual MODFLOW™ was used to develop a qualitative model to estimate the rate of attenuation of the dissolved phase benzene and naphthalene plumes following source removal. Only monitoring wells MW-11I and MW-21I are located along the presumed centerline of the dissolved phase plume migrating from the source area. There are no monitoring wells located downgradient of the source area along the edges of the plume. As such, data are not available to determine the width of the dissolved phase plume and to further refine the biodegradation rate and sorption coefficient. In addition, since the surface water bodies and their influence on groundwater flow were not simulated in the groundwater flow model, the simulated centerline of the plume migrating from the source area is located approximately 140 feet east of Cloud Branch Creek. The simulated plumes (modeled concentrations) were rotated so that the model-predicted plume centerline coincided with monitoring well locations MW-11I and MW-21I, the presumed location of the plume centerline.

The benzene contaminant transport model was calibrated by varying the organic carbon partition coefficient (i.e., sorption coefficient) and the first-order biodegradation rate within the range of literature values to match the model-predicted concentrations to the measured benzene concentration at MW-21I (28 ug/L, measured in May 1999). The contaminant transport model indicates that the benzene plume reached steady-state conditions within approximately 12 years. The initial and final input parameters and their sources for the benzene transport model are presented in Table A-1. The calibrated benzene biodegradation rate of 0.0096/day is within the range of literature values for anaerobic conditions (0.0 to 0.089/day, Suarez and Hanadi, 1999). The median biodegradation rate for benzene under methanogenesis equals 0.010/day, Suarez and Hanadi, 1999. The calibrated organic carbon partition coefficient equals the average value listed in the USEPA *Soil Screening Guidance: Technical Background Document*, USEPA, 1996. Figure A-9 illustrates the extent of the model-predicted benzene groundwater plume at concentrations greater than 1 ug/L (red contour line) prior to source removal.

The naphthalene contaminant transport model was calibrated by varying the organic carbon partition coefficient (i.e., sorption coefficient) and the first-order biodegradation coefficient within the range of

literature values to match the model-predicted concentrations to the measured naphthalene concentration at MW-11I and MW-21I (0.67 mg/L, measured in December 1998 and less than 0.010 mg/L, measured in May 1999, respectively). The contaminant transport model indicates that the naphthalene plume reached steady-state conditions within approximately 40 years. The initial and final input parameters and their sources for the naphthalene transport model are presented in Table A-2. The calibrated biodegradation rate for naphthalene is over one-order of magnitude lower than the literature values (0.0072 to 3.36 l/day, EPRI, 1989). The calibrated organic carbon partition coefficient is within the range of literature values. Figure A-10 illustrates the extent of the model-predicted naphthalene groundwater plume at concentrations greater than 100 ug/L (red contour line) prior to source removal.

Following the calibration of the benzene and naphthalene transport models, the source of groundwater impacts was instantaneously removed (after being present in the system for 120 years) and the model simulated the attenuation of benzene and naphthalene in the groundwater plume. The instantaneous removal of the benzene and naphthalene source was simulated by changing the source concentrations to 0 mg/L after 120 years. This instantaneous removal of the source is appropriate since the remedial action for OU1 involves the removal of NAPL, impacted soil, and impacted groundwater within the source area. The affect of impacts left behind (if any) can be evaluated through OU1 post-monitoring and the model can be used to simulate new conditions to better refine estimates of time for groundwater impacts to attain RGOs.

Figure A-9 shows the extent of benzene concentrations greater than 1 ug/L five years (green contour line) and 10 years (orange contour line) after source removal. Figure A-10 shows the extent of naphthalene concentrations greater than 100 ug/L 10 years (green contour line), 20 years (orange contour line), and 30 years (red contour line) after source removal. Following the instantaneous removal of the source (keeping all other input parameters constant), the contaminant transport model predicts that benzene will not be present within groundwater downgradient of the source at a concentration exceeding the RGO of 1.0 ug/L 12 years after source removal and naphthalene will not be present at a concentration exceeding the RGO of 100 ug/L 33 years after source removal.

Sensitivity Analysis

Table A-3 shows the results of the sensitivity analysis of the ground water flow and contaminant transport model. The sensitivity analysis involved changing the input parameters and evaluating the changes in the predicted time for groundwater concentrations to attenuate to below the RGOs. It should be noted that changing the input parameters caused the model-predicted concentrations at the calibration wells to differ from the measured concentrations (i.e., the model was no longer calibrated). The following input parameters were varied: hydraulic conductivity, porosity, dispersivity, sorption coefficient, biodegradation rate, and source concentration. The model-predicted benzene and naphthalene concentrations for 1999 and the model-predicted time for groundwater concentrations to attenuate to below the RGOs are provided in Table A-3 for each simulation. The sensitivity analysis indicates that the small changes to the sorption coefficient and biodegradation rate for benzene results in large changes in the predicted time for benzene concentrations to decrease to below the RGO. Similarly, small changes to the biodegradation rate for naphthalene result in large changes in the predicted time for naphthalene concentrations to decrease below the RGO. Changes to the groundwater flow parameters (i.e., hydraulic conductivity and porosity) had little affect on the predicted time for groundwater concentrations to attenuate below the RGOs.

A sensitivity analysis was also conducted on the source concentration. Using a higher source concentration for benzene and naphthalene required increasing the biodegradation rate to predict a concentration at the calibration well equal to the measured concentration. Increasing the source concentration and the biodegradation rate resulted in decreasing the predicted time for groundwater concentrations to attenuate to below the RGOs.

Since there is some uncertainty in the biodegradation rates within the aquifer following source removal, a sensitivity analysis was conducted following source removal (Table A-4). As shown by Table A-4, increasing the biodegradation rate significantly decreases the predicted time for benzene and naphthalene concentrations to decrease to below the RGOs and decreasing the biodegradation rate significantly increases the predicted time for groundwater impacts to decrease to below the RGOs. Post source removal groundwater quality and the geochemical environment can be reevaluated through monitoring and additional model simulations to better understand the affect of source removal on the biodecay rate.

Simulation of Engineered Alternatives

The calibrated groundwater flow and contaminant transport model was used to estimate the time for Alternatives 4 and 5 to achieve RGOs. It was assumed that the introduction of ORC (Alternative 4) and air (Alternative 5) to the saturated subsurface would increase the calibrated biodegradation rate for benzene and naphthalene by one order of magnitude. Under these conditions, the model predicts that benzene concentrations would decrease to levels below the RGO in three years (Figure A-11) and naphthalene concentrations would decrease to levels below the RGO in six years (Figure A-12) after source removal (Table A-4).

The calibrated groundwater flow and contaminant transport model was used to estimate the time for Alternative 7 to achieve RGOs. Based on the model results, six extraction wells pumping at a rate of 8 gpm would result in naphthalene groundwater concentrations decreasing to below the RGO in 18 years after source removal (Figure A-13). This pumping scenario would result in benzene concentrations decreasing to below the RGO in seven years after source removal (Figure A-14). The locations of the groundwater extraction wells are also included in Figures A-3 and A-14.

Table A-1
Visual MODFLOW™ Model Input Parameters for Benzene Transport

Input Parameter	Initial Value	Final Value	Source
Model Area L x W (ft)	5000 x 2000	5000 x 2000	Site base map
Horizontal Hydraulic Conductivity (ft/d)	0.6 - 75	40 - 200	Site-specific value / calibration
Horizontal/Vertical Conductivity Ratio	100	100	Literature Value ¹
Effective Porosity	0.25	0.25	Site-specific value
Source Area Dimension L x W x D (ft)	480 x 160	480 x 160	Site-specific value
Source Concentration (µg/L)	2000	2000	Maximum detected concentration in source area (measured at MW-3S)
Source Present in Groundwater (year)	1880	1880	Site-specific value (date plant began operations)
Calibration Well	MW-211	MW-211	Site-specific value
Calibration Concentration (µg/L)	28	28	Site-specific value
Organic Carbon Partition Coefficient (L/kg)	31 and 100	66	Literature Value ^{2,3,6} / calibration
Fraction organic carbon	0.015	0.015	Site-specific value ⁷
First Order Decay (1/d)	0.00095 - 0.095	0.0096	Literature Value ^{2,4} / calibration
Longitudinal Dispersivity (ft)	20	20	Literature value ^{2,5}
Dry Bulk Density (kg/ft ³)	48.1	48.1	Literature Value ²

1. Freeze, R.A. and J.A. Cherry, 1979. Groundwater.
2. USEPA, August 1996. BIOSCREEN Natural Attenuation Decision Support System User's Manual, Version 1.3, Office of Research and Development, Washington, D.C., EPA/600/R-96/087.
3. USEPA, 1986. Superfund Public Health Evaluation Manual. EPA Report No. EPA/540/1-86/060. Office of Solid Waste and Emergency Response, Washington D.C.
4. Suarez, Monica P. and Hanadi S. Rifai, 1999. "Biodegradation Paths for Fuel Hydrocarbons and Chlorinated Solvents in Groundwater." *Bioremediation Journal* 3(4):337-362.
5. Gelhar, L., A. Mantoglou, C. Wertz, and K. Rehfeldt. 1985. *A review of Field-Scale Physical Solute Transport Processes in Saturated and Unsaturated Porous Media*. Electric Power Research Institute, Report EA-4190, Palo Alto, CA.
6. USEPA, 1996. *Soil Screening Guidance: Technical Background Document*. Office of Emergency and Remedial Response, Washington, DC. EPA/540/R95/128.
7. USEPA, April 3, 2000, *Addendum to Feasibility Study and Baseline Risk Assessment Reports*.

Table A-2
Visual MODFLOW™ Model Input Parameters for Naphthalene Transport

Input Parameter	Initial Value	Final Value	Source
Model Area L x W (ft)	5000 x 2000	5000 x 2000	Site base map
Horizontal Hydraulic Conductivity (ft/d)	0.6 – 75	10 - 200	Site-specific value/ calibration
Horizontal/Vertical Conductivity Ratio	100	100	Literature Value ¹
Effective Porosity	0.25	0.25	Site-specific value
Source Area Dimension L x W x D (ft)	480 x 160	480 x 160	Site-specific value
Source Concentration (µg/L)	3800	3800	Maximum detected concentration in source area (measured at MW- SA-4S)
Source Present in Groundwater (year)	1880	1880	Site-specific value (date plant began operations)
Calibration Well	MW-11I and MW- 21I	MW-11I and MW- 21I	Site-specific value
Calibration Concentration (µg/L)	670 and <10	670 and <10	Site-specific value
Organic Carbon Partition Coefficient (L/kg)	830 – 1950	950	Literature Value ^{5,6,7/} calibration
Fraction organic carbon	0.015	0.015	Site-specific value ⁸
First Order Decay – dissolved phase (1/d)	0.077 – 1.63	0.001	Literature Value ^{7/} calibration
First Order Decay – sorbed phase (1/d)	0.0072 – 3.36	0.0002	Literature Value ^{7/} calibration
Longitudinal Dispersivity (ft)	20	20	Literature value ^{2,5}
Dry Bulk Density (kg/ft ³)	48.1	48.1	Literature Value ²

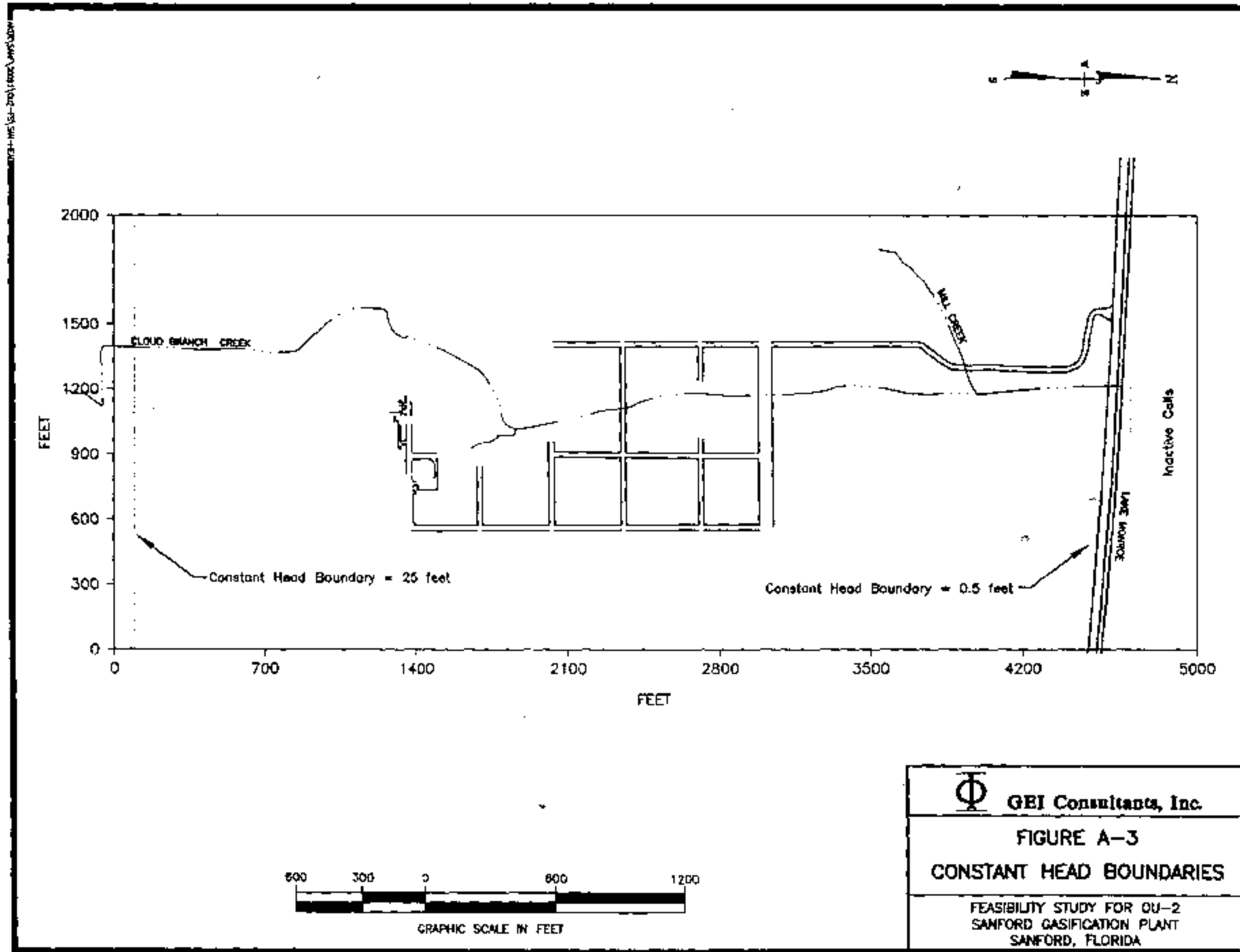
1. Freeze, R.A. and J.A. Cherry, 1979. Groundwater.
2. USEPA, August 1996. BIOSCREEN Natural Attenuation Decision Support System User's Manual, Version 1.3, Office of Research and Development, Washington, D.C., EPA/600/R-96/087.
3. USEPA, 1986. Superfund Public Health Evaluation Manual. EPA Report No. EPA/540/1-86/060. Office of Solid Waste and Emergency Response, Washington D.C.
4. Gelhar, L., A. Mantoglou, C. Weltz, and K. Rehfeldt. 1985. *A review of Field-Scale Physical Solute Transport Processes in Saturated and Unsaturated Porous Media*. Electric Power Research Institute, Report EA-4190, Palo Alto, CA.
5. USEPA, Soil Screening Guidance.
6. Pennsylvania Bulletin, 1997, Volume 27, Number 33. Environmental Quality Board Administration of the Land Recycling Program (Act 2)
7. EPRI, MYGRT™ Code Version 2.0: An IBM Code for Simulating Migration of Organic and Inorganic Chemicals in Groundwater, 1989.
8. USEPA, April 3, 2000, *Addendum to Feasibility Study and Baseline Risk Assessment Reports*.

Table A-3
Sensitivity Analysis

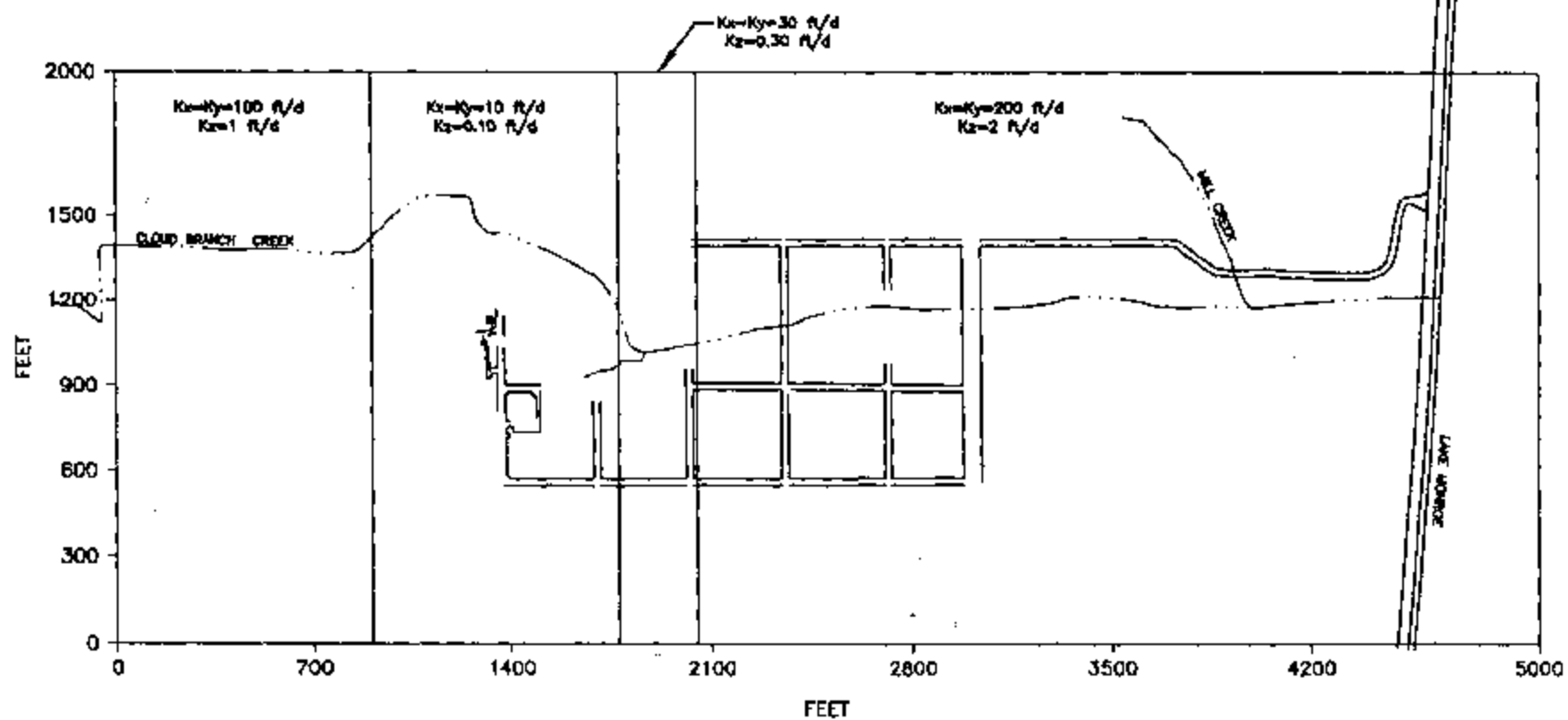
	Benzene Transport Model		Naphthalene Transport Model		
Input Parameters	Concentration at MW-211 (500 feet downgradient of source) in 1999 (µg/L)	Time for Benzene Groundwater Concentrations to Decrease to <1 µg/L at the site (year)	Concentration at MW-111 (140 feet downgradient of source) in 1999 (µg/L)	Concentration at MW-211 (500 feet downgradient of source) in 1999 (µg/L)	Time for Naphthalene Groundwater Concentrations to Decrease to <100 µg/L at the site (year)
Final Model Calibration	34	12	650	7	33
Hydraulic Conductivity					
Decrease by 50%	2.3	13	210	0.2	29
Increase by 100%	190	12	1400	96	34
Porosity					
Decrease by 0.1	100	18	720	7.5	32
Increase by 0.1	13	10	640	6.7	33
Dispersivity					
Increase by 500%	70	11	990	31	26
Sorption Coefficient					
Increase by 50%	35	18	370	0.88	30
Decrease by 50%	36	7	1300	81	32
Biodegradation Rate					
Increase by 50%	7.0	9	370	0.88	22
Decrease by 50%	190	24	1400	90	>67


Table A-4
Results of Sensitivity Analysis on Biodegradation
Rates Following Source Removal

Biodegradation Rate	Time for Concentrations to Decrease to Below the RGO at the Site (year)	
	Benzene	Naphthalene
Initial Value	12	33
Increase by the order of magnitured	3	6
Increase by 50%	9	23
Decrease by 50%	22	53

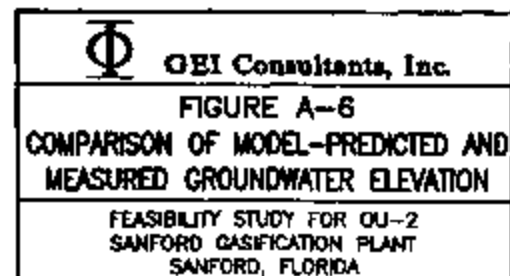
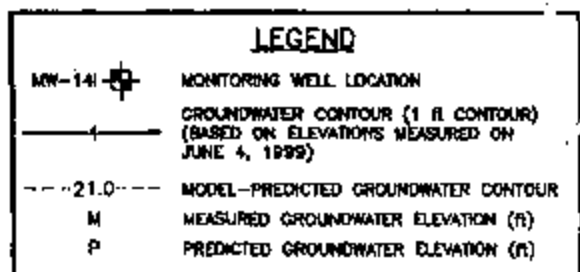
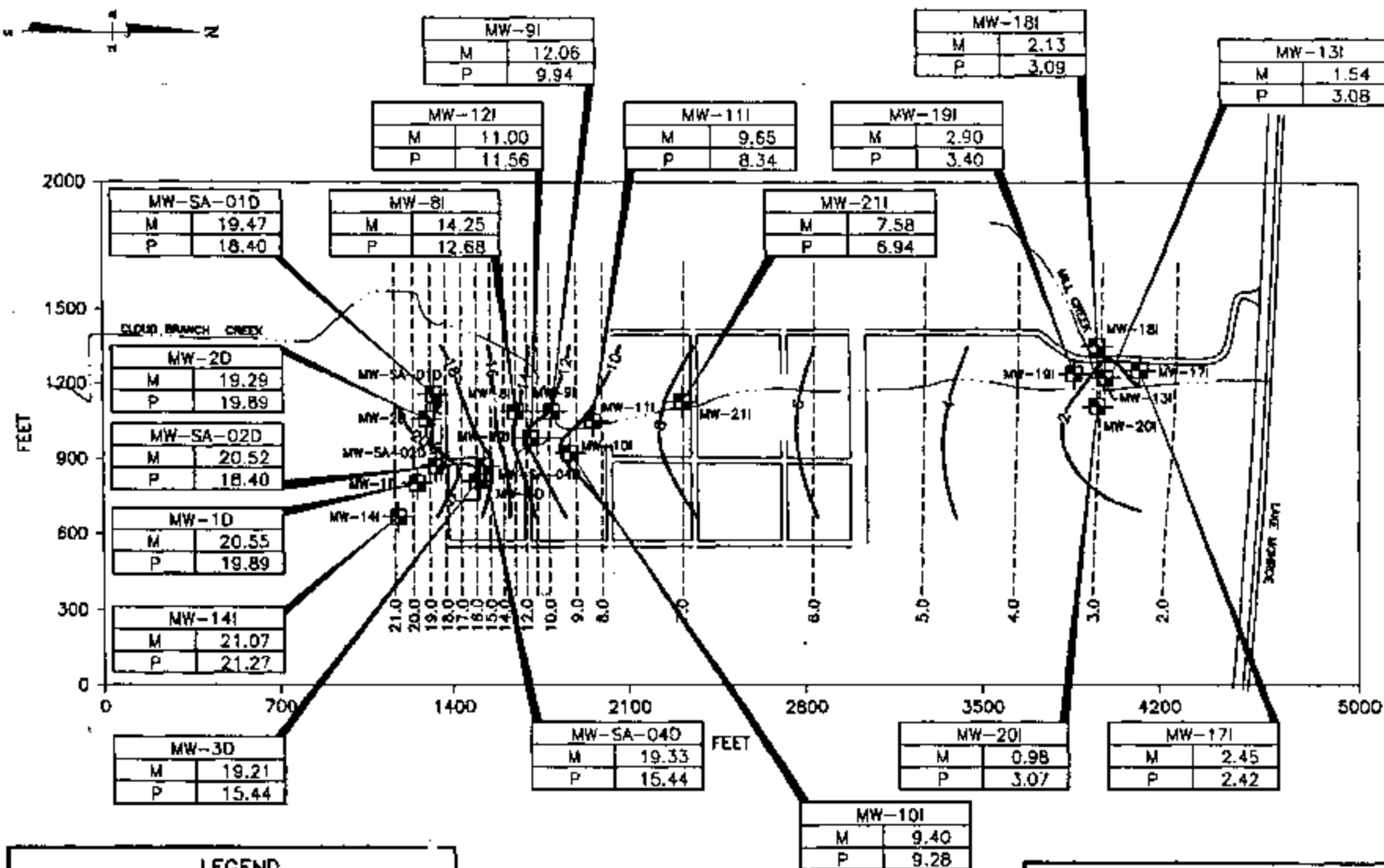


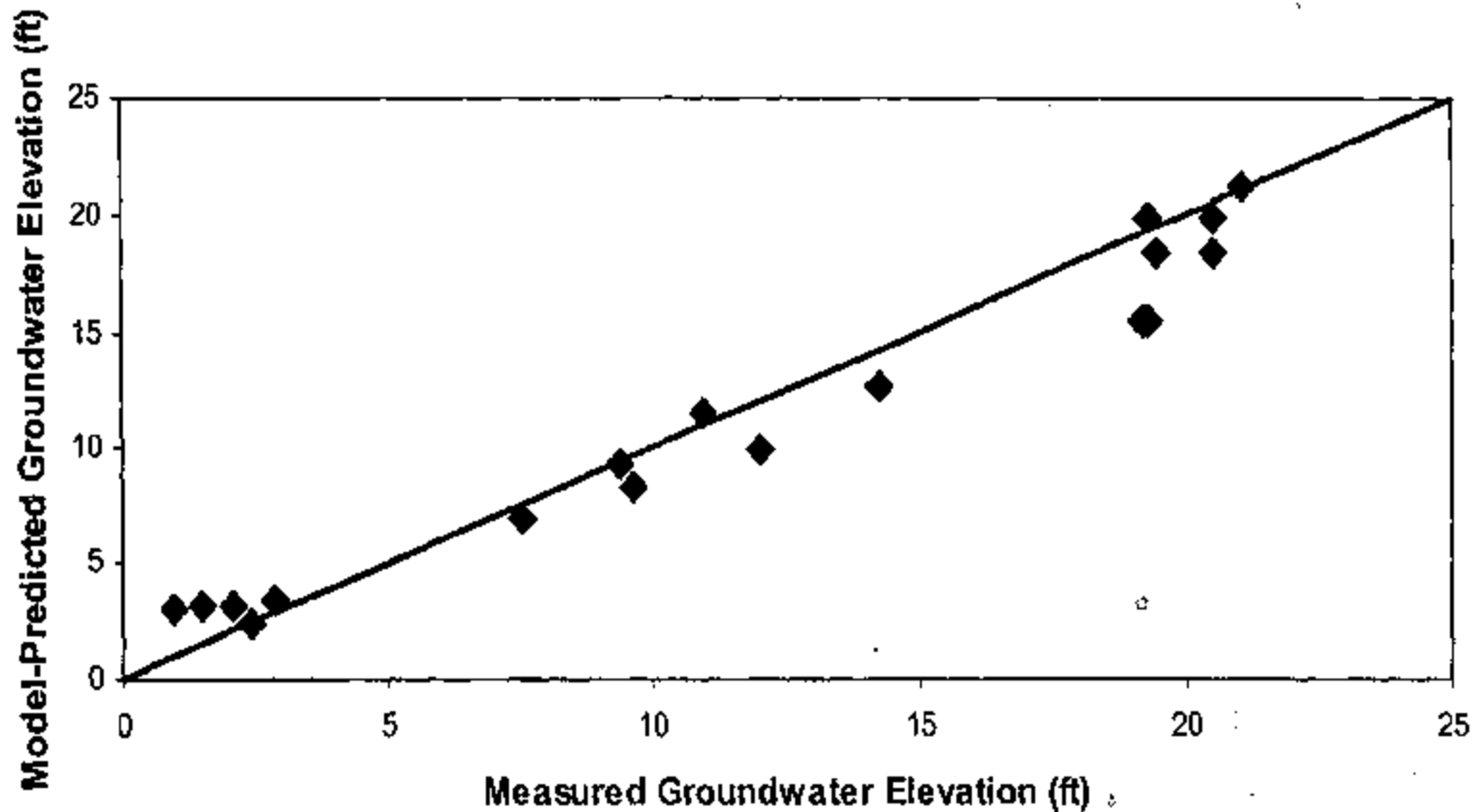
5 9 0060



 GEI Consultants, Inc.
FIGURE A-4
HYDRAULIC CONDUCTIVITY VALUES
FEASIBILITY STUDY FOR OU-2 SANFORD GASIFICATION PLANT SANFORD, FLORIDA

5 9 0069





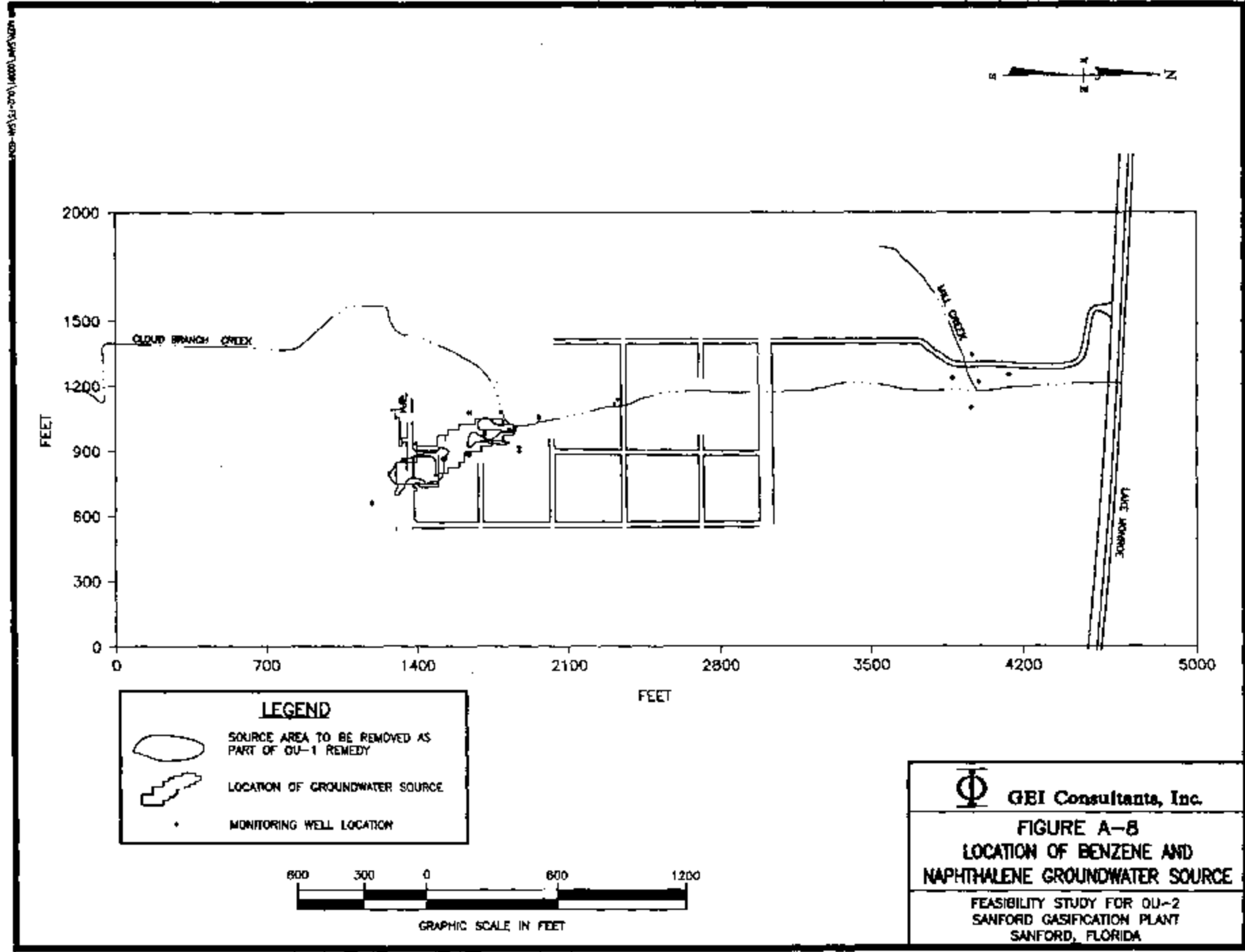
Number of Points: 19
 Mean Error: -0.60298 ft
 Mean Absolute: 1.3197 ft
 Standard Error of the Estimate: 0.3905 ft
 Root Mean Squared: 1.719 ft
 Normalized RMS: 6.558 %



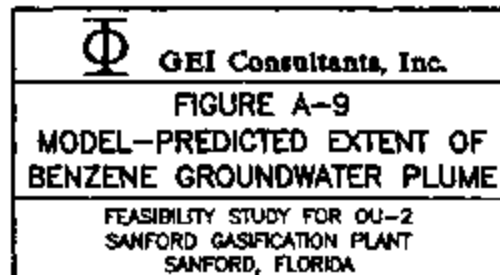
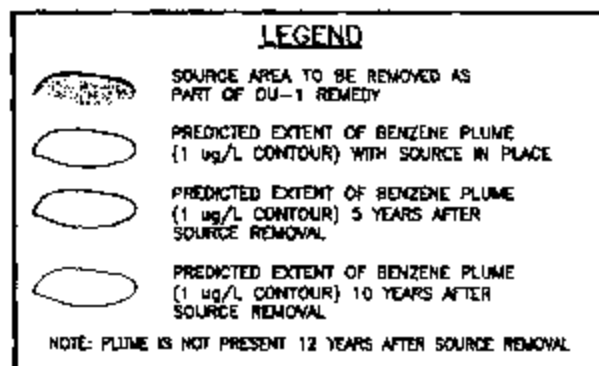
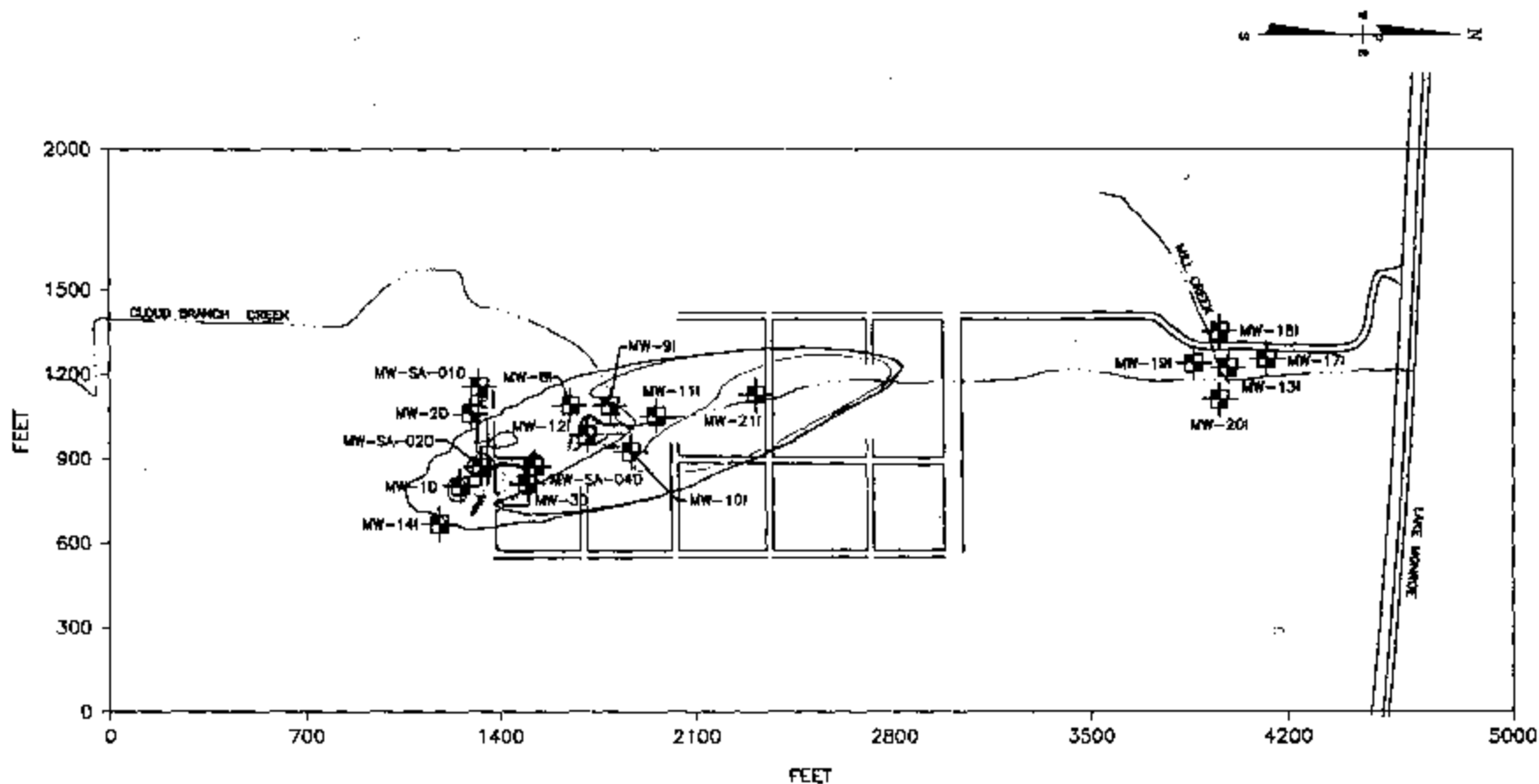
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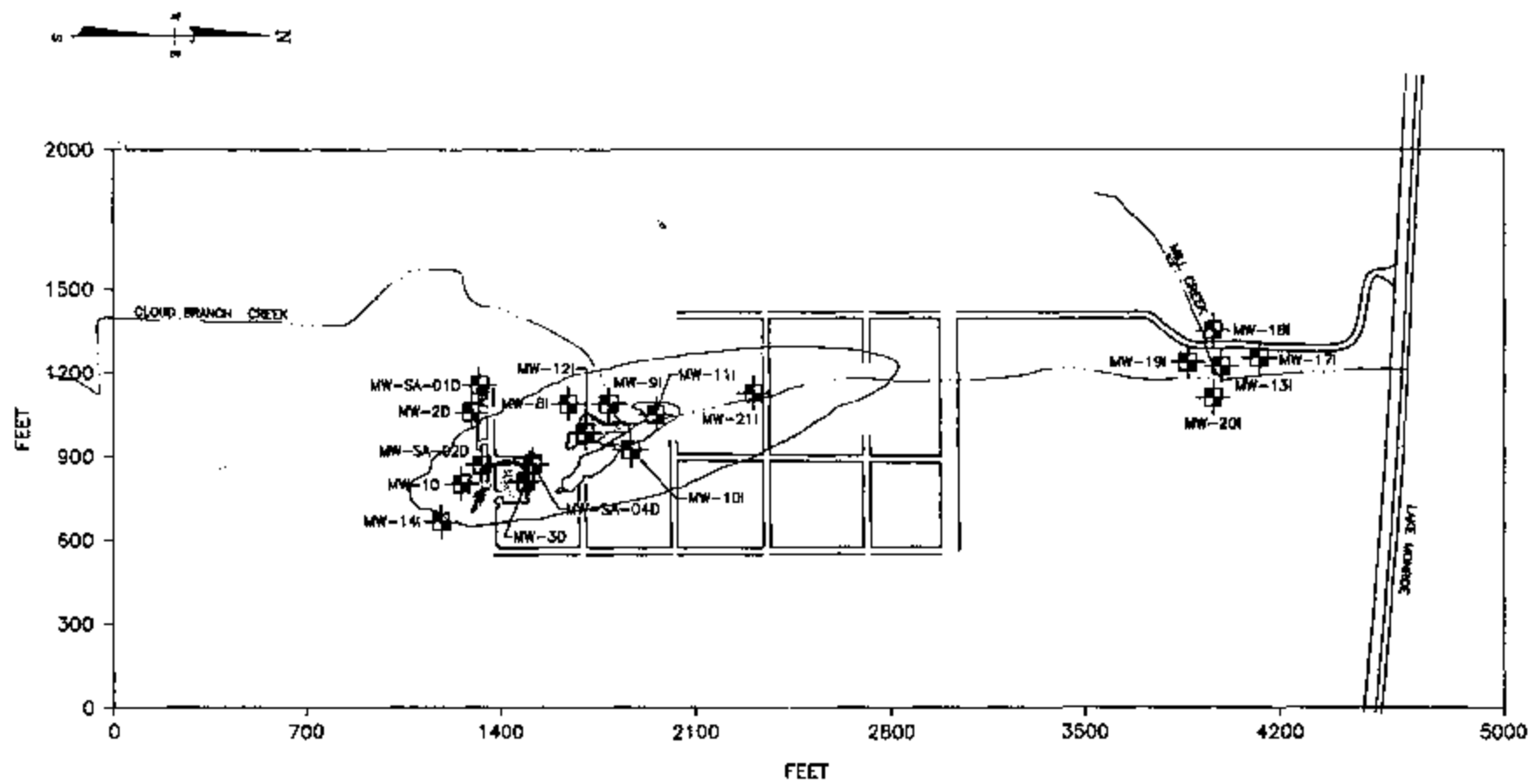
FIGURE A-7
GROUNDWATER FLOW MODEL
CALIBRATION RESULTS

FEASIBILITY STUDY FOR CU-2
 SANFORD GASIFICATION PLANT
 SANFORD, FLORIDA



5 9 0077

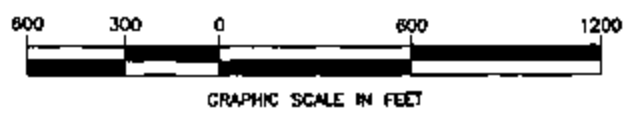




LEGEND

- SOURCE AREA TO BE REMOVED AS PART OF OU-1 REMEDY
- PREDICTED EXTENT OF BENZENE PLUME (1 ug/L CONTOUR) WITH SOURCE IN PLACE
- PREDICTED EXTENT OF BENZENE PLUME (1 ug/L CONTOUR) 2 YEARS AFTER SOURCE REMOVAL

NOTE: PLUME IS NOT PRESENT 3 YEARS AFTER SOURCE REMOVAL

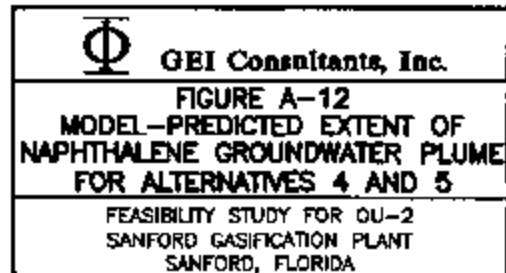
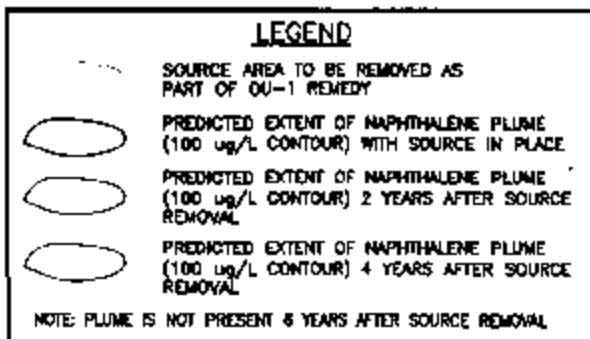
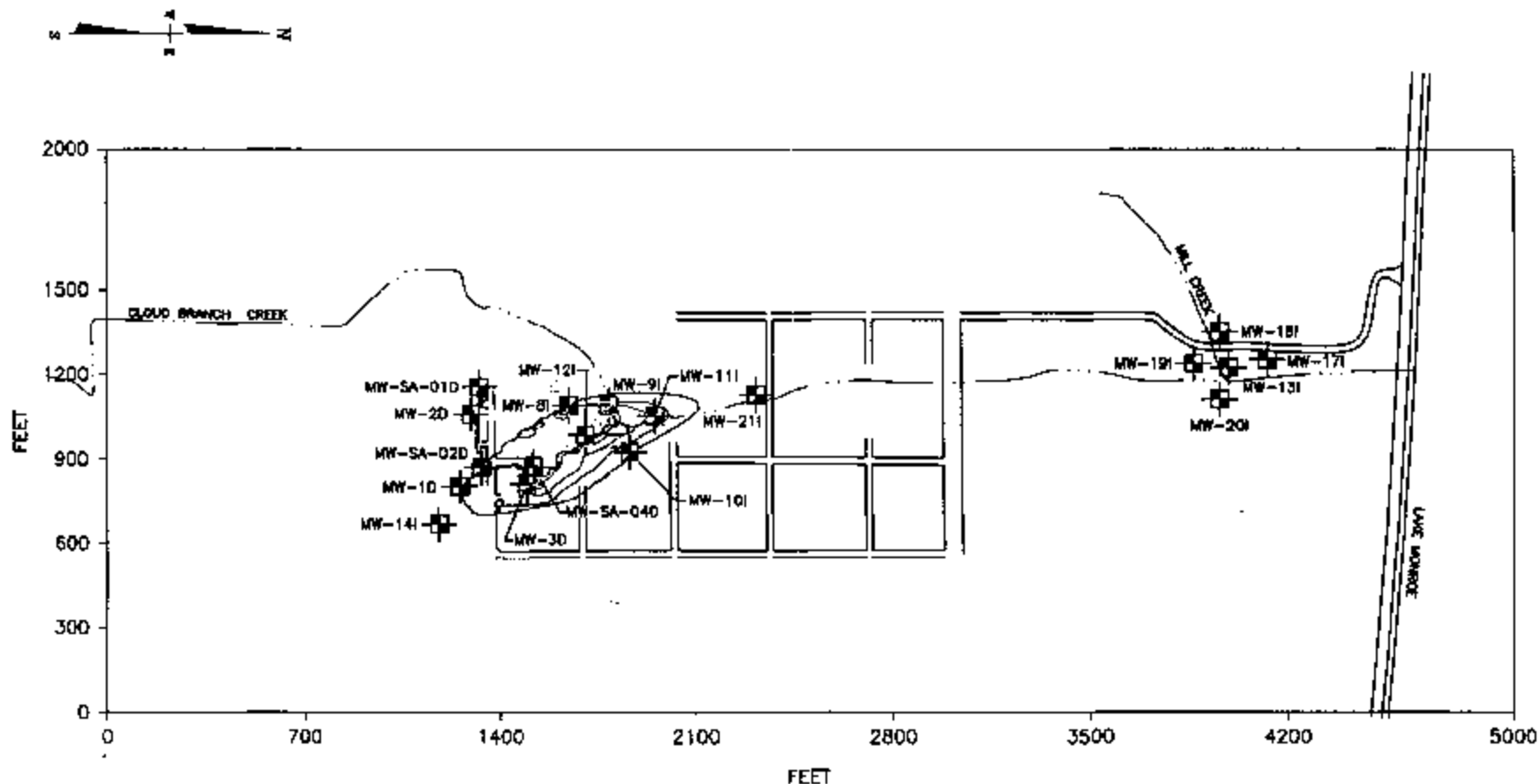


GRI Consultants, Inc.

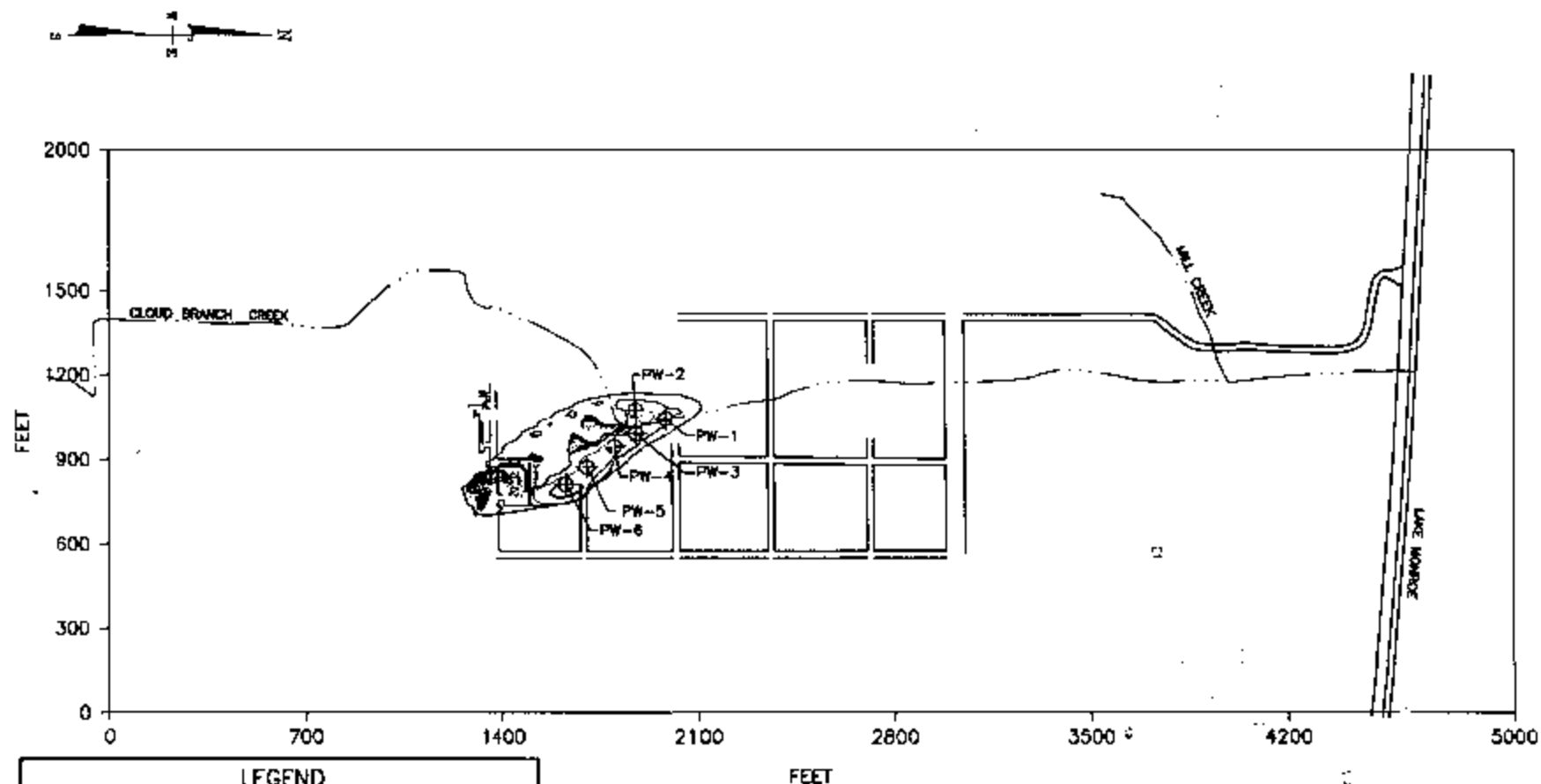
FIGURE A-11
MODEL-PREDICTED EXTENT OF
BENZENE GROUNDWATER PLUME
FOR ALTERNATIVES 4 AND 5

FEASIBILITY STUDY FOR OU-2
 SANFORD GASIFICATION PLANT
 SANFORD, FLORIDA

5 9 0076



DATE: 08/01/00 BY: J. S. S. (JSS)



LEGEND

- PW-1 GROUNDWATER EXTRACTION WELL LOCATION
- SOURCE AREA TO BE REMOVED AS PART OF GU-1 REMEDY
- PREDICTED EXTENT OF NAPHTHALENE PLUME (100 ug/L CONTOUR) PRIOR TO SOURCE REMOVAL
- PREDICTED EXTENT OF NAPHTHALENE PLUME (100 ug/L CONTOUR) 5 YEARS AFTER SOURCE REMOVAL
- PREDICTED EXTENT OF NAPHTHALENE PLUME (100 ug/L CONTOUR) 10 YEARS AFTER SOURCE REMOVAL
- PREDICTED EXTENT OF NAPHTHALENE PLUME (100 ug/L CONTOUR) 15 YEARS AFTER SOURCE REMOVAL

NOTE: PLUME IS NOT PRESENT 16 YEARS AFTER SOURCE REMOVAL



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FIGURE A-13
MODEL-PREDICTED EXTENT OF
NAPHTHALENE GROUNDWATER PLUME
FOR ALTERNATIVE 7 (PUMP & TREAT)

FEASIBILITY STUDY FOR GU-2
 SANFORD GASIFICATION PLANT
 SANFORD, FLORIDA

5 9 0072

APPENDIX B: RESPONSIVENESS SUMMARY

Responsiveness Summary

The Sanford PRP Group raised a concern regarding the ERA. They wanted to know whether EPA would require them further work for OU1 soils since the OU1 environmental assessment for soils was not completed. EPA agreed to have the Sanford PRP Group's contractor submit an Ecological Assessment Compendium for Step 1 for all media and Step 2 and 3 for surface and subsurface soil. The document was submitted to EPA on February 15, 2001. The report concludes that no ecological COPCs are to be retained for the soil cleanup and that no ecological confirmatory samples were required after removal of soil. The document was reviewed and approved by EPA based on the assumption that the excavation of soils will take place and that clean fill will be used to replace it. A copy of the ERA Compendium can be found in the OU2 AR and a copy of the March 5, 2001 letter accepting the report is attached in Appendix E of this ROD.

APPENDIX C: RISK ASSESSMENT INFORMATION

EXPOSURE PATHWAYS

**TABLE 1.1
SELECTION OF EXPOSURE PATHWAYS FOR SURFACE SOIL
FORMER SANFORD MGP**

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current	Surface Soil	Surface Soil	Any on-site or off-site location	Commercial Worker	Adult	Combined (Ingestion/Dermal)	On-site/Off-site	Quant	Workers currently on-site 5 days/week.
				Construction Worker	Adult	Combined (Ingestion/Dermal)	On-site/Off-site	None	No current construction activities.
				Trespasser/Visitor	Adolescent	Combined (Ingestion/Dermal)	On-site/Off-site	Quant	Access restrictions are not in place over entire Facility area.
				Resident	Child/Adult /Aggregate	Combined (Ingestion/Dermal)	On-site/Off-site	None	No residential exposures currently on-site or off-site.
		Air	Any on-site or off-site location	Commercial Worker	Adult	Inhalation	On-site/Off-site	Quant	Workers currently on-site 5 days/week.
				Construction Worker	Adult	Inhalation	On-site/Off-site	None	No current construction activities.
				Trespasser/Visitor	Adolescent	Inhalation	On-site/Off-site	Quant	Access restrictions are not in place over entire Facility area.
				Resident	Child/Adult /Aggregate	Inhalation	On-site/Off-site	None	No residential exposures currently on-site or off-site.
Future	Surface Soil	Surface Soil	Any on-site or off-site location	Commercial Worker	Adult	Combined (Ingestion/Dermal)	On-site/Off-site	Qual	Exposure same or less than current.
				Construction Worker	Adult	Combined (Ingestion/Dermal)	On-site/Off-site	Quant	Potential exists for short-term construction activities.
				Trespasser/Visitor	Adolescent	Combined (Ingestion/Dermal)	On-site/Off-site	Qual	Exposure same or less than current.
				Resident	Child/Adult /Aggregate	Combined (Ingestion/Dermal)	On-site/Off-site	Quant	Potential exists for future residential use on-site and off-site.
		Air	Any on-site or off-site location	Commercial Worker	Adult	Inhalation	On-site/Off-site	Qual	Exposure same or less than current.
				Construction Worker	Adult	Inhalation	On-site/Off-site	Quant	Potential exists for short-term construction activities.
				Trespasser/Visitor	Adolescent	Inhalation	On-site/Off-site	Qual	Exposure same or less than current.
				Resident	Child/Adult /Aggregate	Inhalation	On-site/Off-site	Quant	Potential exists for future residential use on-site and off-site.

Shaded rows are those for which only qualitative analyses are conducted, or for which no exposure pathways are complete.
Details are presented in the right-most column. Unshaded rows indicate that quantitative analyses were conducted.

**TABLE 1.a
SELECTION OF EXPOSURE PATHWAYS FOR SUBSURFACE SOIL
FORMER SANFORD MGP**

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current	Subsurface Soil	Subsurface Soil	Any on-site or off-site location (e.g., utility trench)	Construction Worker	Adult	Combined (Ingestion/Dermal)	On-site/Off-site	None	No current construction activities.
		Air	Any on-site or off-site location (e.g., utility trench)	Construction Worker	Adult	Inhalation	On-site/Off-site	None	No current construction activities.
Future	Subsurface Soil	Subsurface Soil	Any on-site or off-site location (e.g., utility trench)	Construction Worker	Adult	Combined (Ingestion/Dermal)	On-site/Off-site	Quant	Potential exists for short-term construction activities.
		Air	Any on-site or off-site location (e.g., utility trench)	Construction Worker	Adult	Inhalation	On-site/Off-site	Quant	Potential exists for short-term construction activities.

Shaded rows are those for which only qualitative analyses are conducted, or for which no exposure pathways are complete.
Details are presented in the right-most column. Unshaded rows indicate that quantitative analyses were conducted.

TABLE 1.
SELECTION OF EXPOSURE PATHWAYS FOR SEDIMENT
FORMER SANFORD MGP

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current	Sediment	Sediment	Any off-site location	Commercial Worker	Adult	Combined (Ingestion/Dermal)	Off-site	None	Typical commercial exposure not expected in areas having sediment impacts.
				Construction Worker	Adult	Combined (Ingestion/Dermal)	Off-site	None	No current construction activities.
				Trespasser/Visitor	Adolescent	Combined (Ingestion/Dermal)	Off-site	Quant	Warning signs are posted, but access restrictions are not in place in all off-site areas.
				Resident	Child/Adult /Aggregate	Combined (Ingestion/Dermal)	Off-site	Qual	Limited potential nearby residential exposure adequately represented by trespasser/visitor scenario.
		Air	Any off-site location	Trespasser/Visitor	Adolescent	Inhalation	Off-site	Quant	Warning signs are posted, but access restrictions are not in place in all off-site areas.
				Resident	Child/Adult /Aggregate	Inhalation	Off-site	Qual	Limited potential nearby residential exposure adequately represented by trespasser/visitor scenario.
Future	Sediment	Sediment	Any off-site location	Commercial Worker	Adult	Combined (Ingestion/Dermal)	Off-site	None	Typical commercial exposure not expected in areas having sediment impacts.
				Construction Worker	Adult	Combined (Ingestion/Dermal)	Off-site	Quant	Potential exists for short-term construction activities.
				Trespasser/Visitor	Adolescent	Combined (Ingestion/Dermal)	Off-site	Qual	Exposure same or less than current.
				Resident	Child/Adult /Aggregate	Combined (Ingestion/Dermal)	Off-site	Qual	Exposure same or less than current.
		Air	Any off-site location	Construction Worker	Adult	Inhalation	Off-site	Quant	Potential exists for short-term construction activities.
				Trespasser/Visitor	Adolescent	Inhalation	Off-site	Qual	Exposure same or less than current.
				Resident	Child/Adult /Aggregate	Inhalation	Off-site	Qual	Exposure same or less than current.

Shaded rows are those for which only qualitative analyses are conducted, or for which no exposure pathways are complete. Details are presented in the right-most column. Unshaded rows indicate that quantitative analyses were conducted.

**TABLE 1.
SELECTION OF EXPOSURE PATHWAYS FOR GROUNDWATER
FORMER SANFORD MGP**

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current	Groundwater	Groundwater	Any on-site or off-site location	Commercial Worker	Adult	Combined (Ingestion/Dermal)	On-site/Off-site	None	Community-supplied water - no groundwater wells on-site or off-site.
				Construction Worker	Adult	Combined (Ingestion/Dermal)	On-site/Off-site	None	No current construction activities.
				Other Worker (Irrigation Maint)	Adult	Combined (Ingestion/Dermal)	On-site/Off-site	None	No current irrigation maintenance activities.
				Resident	Child/Adult /Aggregate	Combined (Ingestion/Dermal)	On-site/Off-site	None	Community-supplied water - no groundwater wells on-site or off-site.
		Air	Any on-site or off-site location (groundwater-to-ambient air)	Commercial Worker	Adult	Inhalation	On-site/Off-site	None	Due to the limited volatility of the primary COPCs of interest (semivolatiles and inorganics), transfer from groundwater through the soil column to ambient air is not expected to be a significant exposure pathway.
			Any on-site or off-site location (groundwater in a trench)	Construction Worker	Adult	Inhalation	On-site/Off-site	None	No current construction activities.
Future	Groundwater	Groundwater	Any on-site or off-site location	Commercial Worker	Adult	Combined (Ingestion/Dermal)	On-site/Off-site	None	Community-supplied water - no groundwater wells on-site or off-site.
				Construction Worker	Adult	Combined (Ingestion/Dermal)	On-site/Off-site	Quant	Potential exists for short-term construction activities.
				Other Worker (Irrigation Maint)	Adult	Combined (Ingestion/Dermal)	On-site/Off-site	Quant	Potential exists for long-term irrigation/maintenance activities.
				Resident	Child/Adult /Aggregate	Combined (Ingestion/Dermal)	On-site/Off-site	None	Industrial/commercial use of on-site areas assumed to continue. Community-supplied water - no groundwater wells on-site or off-site.
		Air	Any on-site or off-site location (groundwater in a trench)	Construction Worker	Adult	Inhalation	On-site/Off-site	Quant	Potential exists for short-term construction activities.
			Any on-site or off-site location (groundwater sprayed on ground surface)	Other Worker (Irrigation Maint)	Adult	Inhalation	On-site/Off-site	Quant	Potential exists for long-term irrigation/maintenance activities.

Shaded rows are those for which only qualitative analyses are conducted, or for which no exposure pathways are complete. Details are presented in the right-most column. Unshaded rows indicate that quantitative analyses were conducted.

**TABLE 1--
SELECTION OF EXPOSURE PATHWAYS FOR SURFACE WATER
FORMER SANFORD MGP**

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current	Surface Water	Surface Water	Any off-site location	Commercial Worker	Adult	Combined (Ingestion/Dermal)	Off-site	None	Typical commercial exposure not expected in areas having surface water impacts.
				Construction Worker	Adult	Combined (Ingestion/Dermal)	Off-site	None	No current construction activities.
				Swimmer	Child/Adult	Combined (Ingestion/Dermal)	Off-site	None	Only Lake Monroe has sufficient depth for swimming. Alligators and access limitations (3 foot seawall) effectively prevent swimming in nearby areas of Lake Monroe. No significant site-related impacts exist in Lake Monroe.
				Trespasser/Visitor	Adolescent	Combined (Ingestion/Dermal)	Off-site	Quant	Warning signs are posted, but access restrictions are not in place in all off-site areas.
				Resident	Child/Adult /Aggregate	Combined (Ingestion/Dermal)	Off-site	Qual	Residents currently live in some off-site areas having surface water impacts. Typical 350 day/year exposure is not expected, so the trespasser/visitor scenario is assumed to be protective of residents as well.
		Air	Any off-site location	Trespasser/Visitor	Adolescent	Inhalation	Off-site	Quant	Warning signs are posted, but access restrictions are not in place in all off-site areas.
				Resident	Child/Adult /Aggregate	Inhalation	Off-site	Qual	Residents currently live in some off-site areas having surface water impacts. Typical 350 day/year exposure is not expected, so the trespasser/visitor scenario is assumed to be protective of residents as well.
		Fish Tissue	Any off-site location	Fisher	Child/Adult	Fish Ingestion	Off-site	None	Warning signs are posted and access limitations and the nature of the water bodies (i.e., very shallow or intermittent in nature) effectively prevent fishing in areas having surface water impacts.
Future	Surface Water	Surface Water	Any off-site location	Commercial Worker	Adult	Combined (Ingestion/Dermal)	Off-site	None	Typical commercial exposure not expected in areas having surface water impacts.
				Construction Worker	Adult	Combined (Ingestion/Dermal)	Off-site	None	Assumed that construction activities in areas having surface water would involve diverting the surface water away from the construction site.
				Swimmer	Child/Adult	Combined (Ingestion/Dermal)	Off-site	None	Exposure conditions likely will not change from those described for the current timeframe.
				Trespasser/Visitor	Adolescent	Combined (Ingestion/Dermal)	Off-site	Qual	Exposure same or less than current.
				Resident	Child/Adult /Aggregate	Combined (Ingestion/Dermal)	Off-site	Qual	Exposure same or less than current.
		Air	Any off-site location	Trespasser/Visitor	Adolescent	Inhalation	Off-site	Qual	Exposure same or less than current.
				Resident	Child/Adult /Aggregate	Inhalation	Off-site	Qual	Exposure same or less than current.
		Fish Tissue	Any off-site location	Fisher	Child/Adult	Fish Ingestion	Off-site	None	Exposure conditions likely will not change from those described for the current timeframe.

Shaded rows are those for which only qualitative analyses are conducted, or for which no exposure pathways are complete. Details are presented in the right-most column. Unshaded rows indicate that quantitative analyses were conducted.

EXPOSURE ASSUMPTIONS

**TABLE 4.
VALUES USED FOR DAILY INTAKE CALCULATIONS
FORMER SANFORD MGP**

Scenario Timeframe:	Current/Future
Medium:	Surface Soil
Exposure Medium:	Surface Soil

Exposure Point	Receptor Population	Receptor Age	Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	Intake Equation/ Model Name
Any on-site or off-site location	Current/Future Commercial Worker	Adult	Ingestion	CDI	Chronic Daily Intake	mg/kg•day	See Table 7.1a and Table 7.1b		$CDI = \frac{CS \times EF \times ED \times FC \times IR_o \times CF_i}{BW \times AT}$
				CS	Concentration in Soil	mg/kg	See Table 3.1a and Table 3.1b		
				EF	Exposure Frequency	days/year	250	U.S. EPA, 1995a	
				ED	Exposure Duration	years	25	U.S. EPA, 1995a	
				FC	Fraction Contacted (Ingested or absorbed) from contaminated source (assumed 100%)	--	1	U.S. EPA, 1995a	
				IR _o	Oral Ingestion Rate for Soil	mg/day	50	U.S. EPA, 1995a; U.S. EPA, 1997a	
				CF _i	Conversion Factor	kg/mg	1.0E-06	N/A	
				BW	Body Weight	kg	70	U.S. EPA, 1997a	
				AT-NC	Averaging Time for noncarcinogens (period over which exposure is averaged)	days	9,125	= ED * 365	
				AT-C	Averaging Time for carcinogens (period over which exposure is averaged)	days	25,550	U.S. EPA, 1989	
			Dermal	CDI	Chronic Daily Intake	mg/kg•day	See Table 7.1a and Table 7.1b		$CDI = \frac{CS \times EF \times ED \times FC \times SA \times AF \times DA \times CF_i}{BW \times AT}$
				CS	Concentration in Soil	mg/kg	See Table 3.1a and Table 3.1b		
				EF	Exposure Frequency	days/year	250	U.S. EPA, 1995a	
				ED	Exposure Duration	years	25	U.S. EPA, 1995a	
				FC	Fraction Contacted (Ingested or absorbed) from contaminated source (assumed 100%)	--	1	U.S. EPA, 1995a	
				SA	Skin Surface Area available for daily contact	cm ²	2,503	See Appendix E	
				AF	Soil-to-skin Adherence Factor	mg/cm ² /day	0.3	U.S. EPA, 1992a; U.S. EPA, 1995a	
				DA (organics)	Dermal Absorption factor for organics	--	0.01	U.S. EPA, 1995a	
				DA (inorganics)	Dermal Absorption factor for inorganics	--	0.001	U.S. EPA, 1995a	
				CF _i	Conversion Factor	kg/mg	1.0E-06	N/A	
				BW	Body Weight	kg	70	U.S. EPA, 1997a	
				AT-NC	Averaging Time for noncarcinogens (period over which exposure is averaged)	days	9,125	= ED * 365	
				AT-C	Averaging Time for carcinogens (period over which exposure is averaged)	days	25,550	U.S. EPA, 1989	

TABLE 4.1.
VALUES USED FOR DAILY INTAKE CALCULATIONS
FORMER SANFORD MGP

Scenario Timeframe:	Current/Future
Medium:	Surface Soil
Exposure Medium:	Surface Soil

Exposure Point	Receptor Population	Receptor Age	Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	Intake Equation/Model Name
Any on-site or off-site location	Current/Future Trespasser/Visitor	Adolescent	Ingestion	CDI	Chronic Daily Intake	mg/kg•day	See Table 7.2a and Table 7.2b	BPJ U.S. EPA, 1995a U.S. EPA, 1997a N/A U.S. EPA, 1995a; U.S. EPA, 1997a = ED * 365 U.S. EPA, 1989	$CDI = \frac{CS \times EF \times ED \times FC \times IR_o \times CF_i}{BW \times AT}$
				CS	Concentration in Soil	mg/kg	See Table 3.1a and Table 3.1b		
				EF	Exposure Frequency	days/year	50		
				ED	Exposure Duration	years	10		
				FC	Fraction Contacted (ingested or absorbed) from contaminated source (assumed 100%)	--	1		
				IR _o	Oral Ingestion Rate for Soil	mg/day	200		
				CF _i	Conversion Factor	kg/mg	1.0E-06		
				BW	Body Weight	kg	45		
				AT-NC	Averaging Time for noncarcinogens (period over which exposure is averaged)	days	3,650		
				AT-C	Averaging Time for carcinogens (period over which exposure is averaged)	days	25,550		
			Dermal	CDI	Chronic Daily Intake	mg/kg•day	See Table 7.2a and Table 7.2b	BPJ U.S. EPA, 1995a U.S. EPA, 1995a See Appendix E U.S. EPA, 1992a; U.S. EPA, 1995a U.S. EPA, 1995a N/A U.S. EPA, 1995a; U.S. EPA, 1997a = ED * 365 U.S. EPA, 1989	$CDI = \frac{CS \times EF \times ED \times FC \times SA \times AF \times DA \times CF_i}{BW \times AT}$
				CS	Concentration in Soil	mg/kg	See Table 3.1a and Table 3.1b		
				EF	Exposure Frequency	days/year	50		
				ED	Exposure Duration	years	10		
				FC	Fraction Contacted (ingested or absorbed) from contaminated source (assumed 100%)	--	1		
				SA	Skin Surface Area available for daily contact	cm ²	4,041		
				AF	Soil-to-skin Adherence Factor	mg/cm ² /day	0.2		
				DA (organics)	Dermal Absorption factor for organics	--	0.01		
				DA (inorganics)	Dermal Absorption factor for inorganics	--	0.001		
				CF _i	Conversion Factor	kg/mg	1.0E-06		
				BW	Body Weight	kg	45		
				AT-NC	Averaging Time for noncarcinogens (period over which exposure is averaged)	days	3,650		
				AT-C	Averaging Time for carcinogens (period over which exposure is averaged)	days	25,550		

TABLE A
VALUES USED FOR DAILY INTAKE CALCULATIONS
FORMER SANFORD MGP

Scenario Timeframe:	Current/Future
Medium:	Surface Soil
Exposure Medium:	Surface Soil

Exposure Point	Receptor Population	Receptor Age	Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	Intake Equation/Model Name
Any on-site or off-site location	Future Resident	Adult	Ingestion	CDI	Chronic Daily Intake	mg/kg•day	See Table 7.4a and Table 7.4b		$CDI = \frac{CS \times EF \times ED \times FC \times IR_s \times CF_1}{BW \times AT}$
				CS	Concentration in Soil	mg/kg	See Table 3.1b		
				EF	Exposure Frequency	days/year	350	U.S. EPA, 1995a	
				ED	Exposure Duration	years	24	U.S. EPA, 1995a	
				FC	Fraction Contacted (ingested or absorbed) from contaminated source (assumed 100%)	-	1	U.S. EPA, 1995a	
				IR _s	Oral Ingestion Rate for Soil	mg/day	100	U.S. EPA, 1995a	
				CF ₁	Conversion Factor	kg/mg	1.0E-06	N/A	
				BW	Body Weight	kg	70	U.S. EPA, 1997a	
				AT-NC	Averaging Time for noncarcinogens (period over which exposure is averaged)	days	8,760	= ED • 365	
			Dermal	CDI	Chronic Daily Intake	mg/kg•day	See Table 7.4a and Table 7.4b		$CDI = \frac{CS \times EF \times ED \times FC \times SA \times AF \times DA \times CF_1}{BW \times AT}$
				CS	Concentration in Soil	mg/kg	See Table 3.1b		
				EF	Exposure Frequency	days/year	350	U.S. EPA, 1995a	
				ED	Exposure Duration	years	24	U.S. EPA, 1995a	
				FC	Fraction Contacted (ingested or absorbed) from contaminated source (assumed 100%)	-	1	U.S. EPA, 1995a	
				SA	Skin Surface Area available for daily contact	cm ²	4,508	See Appendix E	
				AF	Soil-to-skin Adherence Factor	mg/cm ² /day	0.2	U.S. EPA, 1992; U.S. EPA, 1995	
				DA (organics)	Dermal Absorption factor for organics	-	0.01	U.S. EPA, 1995a	
				DA (inorganics)	Dermal Absorption factor for inorganics	-	0.001	U.S. EPA, 1995a	
				CF ₁	Conversion Factor	kg/mg	1.0E-06	N/A	
				BW	Body Weight	kg	70	U.S. EPA, 1997a	
				AT-NC	Averaging Time for noncarcinogens (period over which exposure is averaged)	days	8,760	= ED • 365	

**TABLE 4.1
VALUES USED FOR DAILY INTAKE CALCULATIONS
FORMER SANFORD MGP**

Scenario Timeframe:	Current/Future
Medium:	Surface Soil
Exposure Medium:	Surface Soil

Exposure Point	Receptor Population	Receptor Age	Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	Intake Equation/Model Name
Any on-site or off-site location	Future Resident	Child	Ingestion	CDI	Chronic Daily Intake	mg/kg•day	See Table 7.3a and Table 7.3b		$CDI = \frac{CS \times EF \times ED \times FC \times IR_a \times CF_1}{BW \times AT}$
				CS	Concentration in Soil	mg/kg	See Table 3.1b		
				EF	Exposure Frequency	days/year	350	U.S. EPA, 1995a	
				ED	Exposure Duration	years	6	U.S. EPA, 1995a	
				FC	Fraction Contacted (ingested or absorbed) from contaminated source (assumed 100%)	-	1	U.S. EPA, 1995a	
				IR _a	Oral Ingestion Rate for Soil	mg/day	200	U.S. EPA, 1995a	
				CF ₁	Conversion Factor	kg/mg	1.0E-06	N/A	
				BW	Body Weight	kg	15	U.S. EPA, 1997a	
				AT-NC	Averaging Time for noncarcinogens (period over which exposure is averaged)	days	2,190	= ED • 365	
			Dermal	CDI	Chronic Daily Intake	mg/kg•day	See Table 7.3a and Table 7.3b		$CDI = \frac{CS \times EF \times ED \times FC \times SA \times AF \times DA \times CF_1}{BW \times AT}$
				CS	Concentration in Soil	mg/kg	See Table 3.1b		
				EF	Exposure Frequency	days/year	350	U.S. EPA, 1995a	
				ED	Exposure Duration	years	6	U.S. EPA, 1995a	
				FC	Fraction Contacted (ingested or absorbed) from contaminated source (assumed 100%)	-	1	U.S. EPA, 1995a	
				SA	Skin Surface Area available for daily contact	cm ²	1,991	See Appendix E	
				AF	Soil-to-skin Adherence Factor	mg/cm ² /day	0.2	U.S. EPA, 1992a; U.S. EPA, 1995a	
				DA (organics)	Dermal Absorption factor for organics	-	0.01	U.S. EPA, 1995a	
				DA (inorganics)	Dermal Absorption factor for inorganics	-	0.001	U.S. EPA, 1995a	
				CF ₁	Conversion Factor	kg/mg	1.0E-06	N/A	
				BW	Body Weight	kg	15	U.S. EPA, 1997a	
				AT-NC	Averaging Time for noncarcinogens (period over which exposure is averaged)	days	2,190	= ED • 365	

**TABLE 4.1
VALUES USED FOR DAILY INTAKE CALCULATIONS
FORMER SANFORD MGP**

Scenario Timeframe:	Current/Future
Medium:	Surface Soil
Exposure Medium:	Surface Soil

Exposure Point	Receptor Population	Receptor Age	Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	Intake Equation/Model Name
Any on-site or off-site location	Future Resident	Aggregate	Ingestion	CDI	Chronic Daily Intake	mg/kg•day	See Table 7.5a and Table 7.5b		$CDI = \frac{CS \times EF \times ED \times FC \times IR_b \times CF_i}{BW \times AT}$
				CS	Concentration in Soil	mg/kg	See Table 3.1b		
				EF	Exposure Frequency	days/year	350	U.S. EPA, 1995a	
				ED	Exposure Duration	years	30	U.S. EPA, 1995a	
				FC	Fraction Contacted (ingested or absorbed) from contaminated source (assumed 100%)	-	1	U.S. EPA, 1995a	
				IR _b	Oral Ingestion Rate for Soil	mg/day	120	See Appendix E	
				CF _i	Conversion Factor	kg/mg	1.0E-06	N/A	
				BW	Body Weight	kg	59	See Appendix E	
				AT-C	Averaging Time for carcinogens (period over which exposure is averaged)	days	25,550	U.S. EPA, 1989	
			Dermal	CDI	Chronic Daily Intake	mg/kg•day	See Table 7.5a and Table 7.5b		$CDI = \frac{CS \times EF \times ED \times FC \times SA \times AF \times DA \times CF_i}{BW \times AT}$
				CS	Concentration in Soil	mg/kg	See Table 3.1b		
				EF	Exposure Frequency	days/year	350	U.S. EPA, 1995a	
				ED	Exposure Duration	years	30	U.S. EPA, 1995a	
				FC	Fraction Contacted (ingested or absorbed) from contaminated source (assumed 100%)	-	1	U.S. EPA, 1995a	
				SA	Skin Surface Area available for daily contact	cm ²	4,005	See Appendix E	
				AF	Soil-to-skin Adherence Factor	mg/cm ² /day	0.2	U.S. EPA, 1992a; U.S. EPA, 1995a	
				DA (organics)	Dermal Absorption factor for organics	-	0.01	U.S. EPA, 1995a	
				DA (inorganics)	Dermal Absorption factor for inorganics	-	0.001	U.S. EPA, 1995a	
				CF _i	Conversion Factor	kg/mg	1.0E-06	N/A	
				BW	Body Weight	kg	59	See Appendix E	
				AT-C	Averaging Time for carcinogens (period over which exposure is averaged)	days	25,550	U.S. EPA, 1989	

BPJ Best Professional Judgement. Trespasser exposure frequency based on two days/week for 50 weeks/year.

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NON-CANCER TOXICITY DATA

TABLE F
NON-CANCER TOXICITY DATA FOR ORAL/DERMAL
FORMER SANFLO AGP

Chemical of Potential Concern	Subchronic Oral R/D Value (1) (mg/kg-day)	Chronic Oral R/D Value (mg/kg-day)	Oral to Dermal Adjustment Factor (2)	Subchronic Adjusted Dermal R/D (3) (mg/kg-day)	Chronic Adjusted Dermal R/D (3) (mg/kg-day)	Primary Target Organ	Combined Uncertainty/Modifying Factors	Sources of R/D/Target Organ	Dates of R/D/Target Organ (4)
Acenaphthene	6.0E-01	6.0E-02	0.8	4.8E-01	4.8E-02	liver	3,000	IRIS/IRIS	Apr 1999/Apr 1999
Acenaphthylene	NF	2.0E-02 (6)	0.8	NF	1.6E-02	blood	3,000 (6)	surrogate	N/A
Acetone	1.0E+00	1.0E-01	0.8	8.0E-01	8.0E-02	liver, kidney	1,000	IRIS/IRIS	Apr 1999/Apr 1999
Aluminum	NF	1.0E+00	0.04 (a)	NF	4.0E-02	CNS	NF	NCEA/DOE	Apr 1999/Apr 1999
Antimony	NF	4.0E-04	0.01 (a)	NF	4.0E-06	blood	1,000	IRIS/IRIS	Apr 1999/Apr 1999
Arsenic	NF	3.0E-04	0.95 (a)	NF	2.9E-04	skin	3	IRIS/IRIS	Apr 1999/Apr 1999
Barium	NF	7.0E-02	0.05 (a)	NF	3.5E-03	NOAEL	3	IRIS/IRIS	Apr 1999/Apr 1999
Benzene	NF	3.0E-03	0.90 (a)	NF	2.7E-03	CNS, blood	NF	NCEA/DOE	Apr 1999/Apr 1999
Benzo(a)anthracene	NF	NF	0.5	NF	NF	NF	NF	NF	N/A
Benzo(a)pyrene	NF	NF	0.5	NF	NF	NF	NF	NF	N/A
Benzo(b and/or k)fluoranthene	NF	NF	0.5	NF	NF	NF	NF	NF	N/A
Benzo(b)fluoranthene	NF	NF	0.5	NF	NF	NF	NF	NF	N/A
Benzo(k)fluoranthene	NF	NF	0.5	NF	NF	NF	NF	NF	N/A
BHC, beta-	NF	NF	0.907 (a)	NF	NF	NF	NF	NF	N/A
Butylbenzene, n-	NF	1.0E-02	0.8	NF	8.0E-03	CNS	NF	NCEA/Cavender	Apr 1999/1994
Butylbenzene, tert-	NF	1.0E-02	0.8	NF	8.0E-03	CNS	NF	NCEA/Cavender	Apr 1999/1994
Cadmium	NF	1.0E-03 (5)	0.044 (a)	NF	4.4E-05	kidney	10	IRIS/IRIS	Apr 1999/Apr 1999
Chlordane, gamma-	NF	5.0E-04	0.5	NF	2.5E-04	liver	300	IRIS/IRIS	Apr 1999/Apr 1999
Chromium (III)	NF	1.5E+00	0.013 (a)	NF	2.0E-02	NOAEL	1,000	IRIS/IRIS	Apr 1999/Apr 1999
Chromium (VI)	2.0E-02	3.0E-03	0.013 (a)	2.4E-04	3.9E-05	NOAEL	900	IRIS/IRIS	Apr 1999/Apr 1999
Chrysene	NF	NF	0.5	NF	NF	NF	NF	NF	N/A
Cobalt	NF	6.0E-02	0.25 (a)	NF	1.5E-02	NF	NF	NCEA/NF	Apr 1999/N/A
Copper	NF	4.0E-02	0.56 (a)	NF	2.2E-02	GI	NF	HEAST/HEAST	1997/1997
Cyanide	NF	2.0E-02	0.2	NF	4.0E-03	NOAEL	500	IRIS/IRIS	Apr 1999/Apr 1999
Dibenzo(a,h)anthracene	NF	NF	0.5	NF	NF	NF	NF	NF	N/A
Dibenzofuran	NF	4.0E-03	0.8	NF	3.2E-03	skin	NF	NCEA/Skene et al.	Apr 1999/1989
Dichloroethane, 1,2-	NF	3.0E-02	1 (a)	NF	3.0E-02	CNS, liver	NF	NCEA/DOE	Apr 1999/Apr 1999
Dichloroethene, 1,1-	NF	9.0E-03	1 (a)	NF	9.0E-03	liver	1,000	IRIS/IRIS	Apr 1999/Apr 1999
Dieldrin	NF	5.0E-05	1 (a)	NF	5.0E-05	liver	100	IRIS/IRIS	Apr 1999/Apr 1999
Ethylbenzene	NF	1.0E-01	0.8	NF	8.0E-02	liver, kidney	1,000	IRIS/IRIS	Apr 1999/Apr 1999
Fluoranthene	4.0E-01	4.0E-02	0.5	2.0E-01	2.0E-02	liver, kidney, blood	3,000	IRIS/IRIS	Apr 1999/Apr 1999
Fluorene	4.0E-01	4.0E-02	0.8	3.2E-01	3.2E-02	blood	300	IRIS/IRIS	Apr 1999/Apr 1999
Indeno(1,2,3-c,d)pyrene	NF	NF	0.5	NF	NF	NF	NF	NF	N/A
Iron	NF	3.0E-01	0.085 (a)	NF	2.6E-02	GI	NF	NCEA/Nieminen & Lemasters	Apr 1999/1996
Isopropylbenzene	4.0E-01	1.0E-01	0.8	3.2E-01	8.0E-02	kidney	1,000	IRIS/IRIS	Apr 1999/Apr 1999
Lead	NF	NF	N/A	NF	NF	NF	NF	NF	N/A
Manganese	1.4E-01	2.0E-02	0.04 (a)	5.6E-03	8.0E-04	CNS	1	IRIS/IRIS	Apr 1999/Apr 1999
Mercury	NF	1.0E-04 (6)	0.10 (a)	NF	1.0E-05	development, CNS	1,000 (6)	surrogate	N/A
Methyl-4,6-dinitrophenol, 2-	NF	1.0E-04	0.5	NF	5.0E-05	NF	NF	NCEA/NF	Apr 1999/N/A
Methylene chloride	NF	6.0E-02	1 (a)	NF	6.0E-02	liver	100	IRIS/IRIS	Apr 1999/Apr 1999

TABLE 5
NON-CANCER TOXICITY D. ORAL/DERMAL
FORMER SANFC AIGP

Chemical of Potential Concern	Subchronic Oral R/D Value (1) (mg/kg•day)	Chronic Oral R/D Value (mg/kg•day)	Oral to Dermal Adjustment Factor (2)	Subchronic Adjusted Dermal R/D (3) (mg/kg•day)	Chronic Adjusted Dermal R/D (3) (mg/kg•day)	Primary Target Organ	Combined Uncertainty/Modifying Factors	Sources of R/D/Target Organ	Dates of R/D/Target Organ (4)
Methylnaphthalene, 1-	NF	2.0E-02 (6)	0.8	NF	1.6E-02	NF	NF	surrogate	N/A
Methylnaphthalene, 2-	NF	2.0E-02	0.8	NF	1.6E-02	NF	NF	NCEA/NF	Apr 1999/N/A
Naphthalene	NF	2.0E-02	1 (a)	NF	2.0E-02	body weight	3,000	IRIS/IRIS	Apr 1999/Apr 1999
N-Nitrosodi-n-propylamine	NF	NF	0.5	NF	NF	NF	NF	NF	N/A
Nitroaniline, 2-	NF	NF	0.5	NF	NF	NF	NF	NF	N/A
Nitroaniline, 4-	NF	NF	0.5	NF	NF	NF	NF	NF	N/A
Phenanthrene	NF	2.0E-02 (6)	0.8	NF	1.6E-02	body weight	3,000 (6)	surrogate	N/A
Propylbenzene, n-	NF	1.0E-02	0.8	NF	8.0E-03	NF	NF	NCEA/NF	Apr 1999/N/A
Pyrene	3.0E-01	3.0E-02	0.5	1.5E-01	1.5E-02	kidney	3,000	IRIS/IRIS	Apr 1999/Apr 1999
Toluene	2.0E+00	2.0E-01	0.8	1.6E+00	1.6E-01	kidney, liver	1,000	IRIS/IRIS	Apr 1999/Apr 1999
Trimethylbenzene, 1,2,4-	NF	5.0E-02	0.8	NF	4.0E-02	NF	NF	NCEA/NF	Apr 1999/N/A
Trimethylbenzene, 1,3,5-	NF	5.0E-02	0.8	NF	4.0E-02	NF	NF	NCEA/NF	Apr 1999/N/A
Vanadium	NF	7.0E-03	0.026 (a)	NF	1.8E-04	NOAEL	100	HEAST/HEAST	1997/1997
Xylenes, m&p-	NF	2.0E+00 (6)	0.8	NF	1.6E+00	hyperact, body weight	100	IRIS/IRIS	Apr 1999/Apr 1999
Xylenes, o-	NF	2.0E+00 (6)	0.8	NF	1.6E+00	hyperact, body weight	100	IRIS/IRIS	Apr 1999/Apr 1999
Xylenes, Total	NF	2.0E+00	0.895 (a)	NF	1.8E+00	hyperact, body weight	100	IRIS/IRIS	Apr 1999/Apr 1999
Zinc	NF	3.0E-01	0.25 (a)	NF	7.5E-02	blood	3	IRIS/IRIS	Apr 1999/Apr 1999

N/A = Not Applicable.

NF = Not Found.

(1) All subchronic R/Ds were obtained from HEAST, 1997.

(2) Values obtained from current ATSDR profiles unless marked (a).

(a) Indicates a factor of 0.8 for volatiles, 0.5 for semivolatiles and 0.2 for inorganics, per Region IV guidance.

(3) Oral R/D multiplied by the oral-to-dermal adjustment factor.

(4) For IRIS values, the date IRIS was searched.

For DOE values, the date of the web site search.

For NCEA values, the date of the Region III RBC Table.

(5) Oral R/D for cadmium in food - for exposure to groundwater, the oral R/D for cadmium in water (5E-04) was used.

(6) Surrogate values based on closely related compounds as follows:

naphthalene for acenaphthylene and phenanthrene

methyl mercury for mercury

2-methylnaphthalene for 1-methylnaphthalene

total xylenes for m&p- and o-xylene

CNS = Central Nervous System

GI = Gastrointestinal

NOAEL = No Observed Adverse Effects Level

IRIS = Integrated Risk Information System

DOE = Department of Energy (website)

HEAST = Health Effects Assessment Summary Tables

NCEA = National Center for Environmental Assessment

ATSDR = Agency for Toxic Substances and Disease Registry

TABLE 5.2
NON-CANCER TOXICITY D FORMER SANFL INHALATION GP

Chemical of Potential Concern	Subchronic Inhalation RfC Value (1) (mg/m ³)	Chronic Inhalation RfC Value (mg/m ³)	Subchronic Adjusted Inhalation RfD (2) (mg/kg-day)	Chronic Adjusted Inhalation RfD (2) (mg/kg-day)	Primary Target Organ	Combined Uncertainty/Modifying Factors	Sources of RfC,RfD/Target Organ	Dates of RfC,RfD/Target Organ (3)
Acenaphthene	NF	NF	NF	NF	NF	NF	NF	N/A
Acenaphthylene	NF	NF	NF	NF	NF	NF	NF	N/A
Acetone	NF	NF	NF	NF	NF	NF	NF	N/A
Aluminum	NF	NF	NF	1.0E-03	lung	NF	NCEA/DOE	Apr 1999/Apr 1999
Antimony	NF	NF	NF	NF	NF	NF	NF	N/A
Arsenic	NF	NF	NF	NF	NF	NF	NF	N/A
Barium	5.0E-03	5.0E-04	1.4E-03	1.4E-04	respiratory, blood pressure	1,000	HEAST/DOE	1997/Apr 1999
Benzene	NF	NF	NF	1.7E-03	blood, CNS	NF	NCEA/DOE	Apr 1999/Apr 1999
Benzo(a)anthracene	NF	NF	NF	NF	NF	NF	NF	N/A
Benzo(a)pyrene	NF	NF	NF	NF	NF	NF	NF	N/A
Benzo(b and/or k)fluoranthene	NF	NF	NF	NF	NF	NF	NF	N/A
Benzo(b)fluoranthene	NF	NF	NF	NF	NF	NF	NF	N/A
Benzo(k)fluoranthene	NF	NF	NF	NF	NF	NF	NF	N/A
BHC, beta-	NF	NF	NF	NF	NF	NF	NF	N/A
Butylbenzene, n-	NF	NF	NF	NF	NF	NF	NF	N/A
Butylbenzene, tert-	NF	NF	NF	NF	NF	NF	NF	N/A
Cadmium	NF	NF	NF	NF	NF	NF	NF	N/A
Chlordane, gamma-	NF	7.0E-04	NF	2.0E-04	liver	1,000	IRIS/IRIS	Apr 1999/Apr 1999
Chromium (III)	NF	NF	NF	NF	NF	NF	NF	N/A
Chromium (VI)	NF	1.0E-04	NF	2.9E-05	respiratory	300	IRIS/IRIS	Apr 1999/Apr 1999
Chrysene	NF	NF	NF	NF	NF	NF	NF	N/A
Cobalt	NF	NF	NF	NF	NF	NF	NF	N/A
Copper	NF	NF	NF	NF	NF	NF	NF	N/A
Cyanide	NF	NF	NF	NF	NF	NF	NF	N/A
Dibenzo(a,h)anthracene	NF	NF	NF	NF	NF	NF	NF	N/A
Dibenzofuran	NF	NF	NF	NF	NF	NF	NF	N/A
Dichloroethane, 1,2-	NF	NF	NF	1.4E-03	CNS, kidney, liver	NF	NCEA/DOE	Apr 1999/Apr 1999
Dichloroethane, 1,1-	NF	NF	NF	NF	NF	NF	NF	N/A
Dieldrin	NF	NF	NF	NF	NF	NF	NF	N/A
Ethylbenzene	NF	1.0E+00	NF	2.86E-01	developmental	300	IRIS/IRIS	Apr 1999/Apr 1999
Fluoranthene	NF	NF	NF	NF	NF	NF	NF	N/A
Fluorene	NF	NF	NF	NF	NF	NF	NF	N/A
Indeno (1,2,3-c,d)pyrene	NF	NF	NF	NF	NF	NF	NF	N/A
Iron	NF	NF	NF	NF	NF	NF	NF	N/A
Isopropylbenzene	NF	4.0E-01	NF	1.1E-01	kidney, adrenal	1,000	IRIS/IRIS	Apr 1999/Apr 1999
Lead	NF	NF	NF	NF	NF	NF	NF	N/A
Manganese	NF	5.0E-05	NF	1.4E-05	CNS	1,000	IRIS/IRIS	Apr 1999/Apr 1999
Mercury	NF	3.0E-04	NF	8.6E-05	CNS	30	IRIS/IRIS	Apr 1999/Apr 1999
Methyl-4,6-dinitrophenol, 2-	NF	NF	NF	NF	NF	NF	NF	N/A
Methylene chloride	NF	3.0E+00	NF	8.6E-01	liver	100	HEAST/DOE	1997/Apr 1999

**TABLE 5
NON-CANCER TOXICITY D. INHALATION
FORMER SANFORD MGP**

Chemical of Potential Concern	Subchronic Inhalation RfC Value (1) (mg/m ³)	Chronic Inhalation RfC Value (mg/m ³)	Subchronic Adjusted Inhalation RfD (2) (mg/kg·day)	Chronic Adjusted Inhalation RfD (2) (mg/kg·day)	Primary Target Organ	Combined Uncertainty/Modifying Factors	Sources of RfC,RfD/Target Organ	Dates of RfC,RfD/Target Organ (3)
Methylnaphthalene, 1-	NF	3.0E-03	NF	8.6E-04	nasal	NF	surrogate	N/A
Methylnaphthalene, 2-	NF	3.0E-03	NF	8.6E-04	nasal	NF	surrogate	N/A
Naphthalene	NF	3.0E-03	NF	8.6E-04	nasal	3,000	IRIS/IRIS	Apr 1999/Apr 1999
N-Nitrosodi-n-propylamine	NF	NF	NF	NF	NF	NF	NF	N/A
Nitroaniline, 2-	2.0E-03	2.0E-04	5.7E-04	5.7E-05	blood	10,000	HEAST/DOE	1997/Apr 1999
Nitroaniline, 4-	2.0E-03 (4)	2.0E-04 (4)	5.7E-04 (4)	5.7E-05 (4)	NF	NF	surrogate	N/A
Phenanthrene	NF	NF	NF	NF	NF	NF	NF	N/A
Propylbenzene, n-	NF	NF	NF	NF	NF	NF	NF	N/A
Pyrene	NF	NF	NF	NF	NF	NF	NF	N/A
Toluene	NF	4.0E-01	NF	1.1E-01	CNS	300	IRIS/IRIS	Apr 1999/Apr 1999
Trimethylbenzene, 1,2,4-	NF	NF	NF	1.7E-03	CNS	NF	NCEA/DOE	Apr 1999/Apr 1999
Trimethylbenzene, 1,3,5-	NF	NF	NF	1.7E-03	CNS	NF	NCEA/DOE	Apr 1999/Apr 1999
Vanadium	NF	NF	NF	NF	NF	NF	NF	N/A
Xylenes, m&p-	NF	NF	NF	NF	NF	NF	NF	N/A
Xylenes, o-	NF	NF	NF	NF	NF	NF	NF	N/A
Xylenes, Total	NF	NF	NF	NF	NF	NF	NF	N/A
Zinc	NF	NF	NF	NF	NF	NF	NF	N/A

N/A = Not Applicable

NF = Not Found.

(1) All subchronic RfCs were obtained from HEAST, 1997.

(2) Derived by multiplying the RfC by the inhalation rate of 20m³/day and dividing by the body weight of 70 kg.

(3) For IRIS values, the date IRIS was searched.

For DOE values, the date of the web site search.

For NCEA values, the date of the Region III RfC Table.

(4) Surrogate values based on 2-nitroaniline.

CNS = Central Nervous System

IRIS = Integrated Risk Information System

DOE = Department of Energy (website)

HEAST = Health Effects Assessment Summary Tables

NCEA = National Center for Environmental Assessment

CANCER TOXICITY DATA

TABLE 6.
CANCER TOXICITY DATA
FORMER SANFO
AL/DERMAL
GP

Chemical of Potential Concern	Oral Cancer Slope Factor (mg/kg-day) ⁻¹	Oral to Dermal Adjustment Factor	Adjusted Dermal Cancer Slope Factor (1) (mg/kg-day) ⁻¹	Weight of Evidence/ Cancer Guideline Description	Source Cancer Slope Factor	Date (2)
Acenaphthene	N/A	0.8	N/A	Not Likely	N/A	N/A
Acenaphthylene	N/A	0.8	N/A	Not Likely	N/A	N/A
Acetone	N/A	0.8	N/A	Not Likely	N/A	N/A
Aluminum	N/A	0.04	N/A	Not Likely	N/A	N/A
Antimony	N/A	0.01	N/A	Not Likely	N/A	N/A
Arsenic	1.5E+00	0.95	1.6E+00	Known/Likely/A	IRIS	Apr 1999
Barium	N/A	0.05	N/A	Not Likely	N/A	N/A
Benzene	2.9E-02	0.9	3.2E-02	Known/Likely/A	IRIS	Apr 1999
Benzo(a)anthracene	7.3E-01	0.5	1.5E+00	Known/Likely/B2	TEF	N/A
Benzo(a)pyrene	7.3E+00	0.5	1.5E+01	Known/Likely/B2	IRIS	Apr 1999
Benzo(b and/or k)fluoranthene	7.3E-01	0.5	1.5E+00	Known/Likely/B2	TEF	N/A
Benzo(b)fluoranthene	7.3E-01	0.5	1.5E+00	Known/Likely/B2	TEF	N/A
Benzo(k)fluoranthene	7.3E-02	0.5	1.5E-01	Known/Likely/B2	TEF	N/A
BHC, beta-	1.8E+00	0.907	2.0E+00	Known/Likely/C	IRIS	Apr 1999
Butylbenzene, n-	N/A	0.8	N/A	Not Likely	N/A	N/A
Butylbenzene, tert-	N/A	0.8	N/A	Not Likely	N/A	N/A
Cadmium	N/A	0.044	N/A	Not Likely	N/A	N/A
Chlordane, gamma-	3.5E-01	0.5	7.0E-01	Known/Likely/B2	IRIS	Apr 1999
Chromium (III)	N/A	0.013	N/A	Not Likely	N/A	N/A
Chromium (VI)	N/A	0.013	N/A	Not Likely	N/A	N/A
Chrysene	7.3E-03	0.5	1.5E-02	Known/Likely/B2	TEF	N/A
Cobalt	N/A	0.25	N/A	Not Likely	N/A	N/A
Copper	N/A	0.56	N/A	Cannot be determined/D	N/A	N/A
Cyanide	N/A	0.2	N/A	Cannot be determined/D	N/A	N/A
Dibenzo(a,h)anthracene	7.3E+00	0.5	1.5E+01	Known/Likely/B2	TEF	N/A
Dibenzofuran	N/A	0.8	N/A	Not Likely	N/A	N/A
Dichloroethane, 1,2-	9.1E-02	1.0	9.1E-02	Known/Likely/B2	IRIS	Apr 1999
Dichloroethene, 1,1-	6.0E-01	1.0	6.0E-01	Known/Likely/C	IRIS	Apr 1999
Dieldrin	1.6E+01	1.0	1.6E+01	Known/Likely/B2	IRIS	Apr 1999
Ethylbenzene	N/A	0.8	N/A	Cannot be determined/D	N/A	N/A
Fluoranthene	N/A	0.5	N/A	Cannot be determined/D	N/A	N/A
Fluorene	N/A	0.8	N/A	Not Likely	N/A	N/A
Indeno(1,2,3-c,d)pyrene	7.3E-01	0.5	1.5E+00	Known/Likely/B2	TEF	N/A
Iron	N/A	0.085	N/A	Cannot be determined/D	N/A	N/A
Isopropylbenzene	N/A	0.8	N/A	Not Likely	N/A	N/A
Lead	N/A	N/A	N/A	Not Likely	N/A	N/A
Manganese	N/A	0.04	N/A	Cannot be determined/D	N/A	N/A
Mercury	N/A	0.1	N/A	Not Likely	N/A	N/A
Methyl-4,6-dinitrophenol, 2-	N/A	0.5	N/A	Not Likely	N/A	N/A
Methylene chloride	7.5E-03	1.0	7.5E-03	Known/Likely/B2	IRIS	Apr 1999

TABLE 6 *
CANCER TOXICITY DATA
FORMER SANI **AL/DERMAL**
IGP

Chemical of Potential Concern	Oral Cancer Slope Factor (mg/kg-day) ⁽¹⁾	Oral to Dermal Adjustment Factor	Adjusted Dermal Cancer Slope Factor (1) (mg/kg-day) ⁽¹⁾	Weight of Evidence / Cancer Guideline Description	Source Cancer Slope Factor	Date (2)
Methylnaphthalene, 1-	N/A	0.8	N/A	Not Likely	N/A	N/A
Methylnaphthalene, 2-	N/A	0.8	N/A	Not Likely	N/A	N/A
Naphthalene	N/A	1.0	N/A	Cannot be determined / D	N/A	N/A
N-Nitrosodi-n-propylamine	7.0E+00	0.5	1.4E+01	Known / Likely / B2	IRIS	Apr 1999
Nitroaniline, 2-	N/A	0.5	N/A	Not Likely	N/A	N/A
Nitroaniline, 4-	N/A	0.5	N/A	Not Likely	N/A	N/A
Phenanthrene	N/A	0.8	N/A	Cannot be determined / D	N/A	N/A
Propylbenzene, n-	N/A	0.8	N/A	Not Likely	N/A	N/A
Pyrene	N/A	0.5	N/A	Not Likely	N/A	N/A
Toluene	N/A	0.8	N/A	Cannot be determined / D	N/A	N/A
Trimethylbenzene, 1,2,4-	N/A	0.8	N/A	Not Likely	N/A	N/A
Trimethylbenzene, 1,3,5-	N/A	0.8	N/A	Not Likely	N/A	N/A
Vanadium	N/A	0.026	N/A	Not Likely	N/A	N/A
Xylenes, m&p-	N/A	0.8	N/A	Not Likely	N/A	N/A
Xylenes, o-	N/A	0.8	N/A	Not Likely	N/A	N/A
Xylenes, Total	N/A	0.895	N/A	Not Likely	N/A	N/A
Zinc	N/A	0.25	N/A	Cannot be determined / D	N/A	N/A

N/A Not applicable.

IRIS = Integrated Risk Information System

TEF=Benzo(a)pyrene Toxicity Equivalence Factor methodology

(1) Oral CSF divided by the dermal adjustment factor (see Table 5.1).

(2) For IRIS values, the date IRIS was searched.

Cancer Group:

A - Human carcinogen

B1 - Probable human carcinogen - Indicates that limited human data are available

B2 - Probable human carcinogen - Indicates sufficient evidence in animals and inadequate or no evidence in humans

C - Possible human carcinogen

D - Not classifiable as a human carcinogen

E - Evidence of noncarcinogenicity

Weight of Evidence:

Known / Likely

Cannot be Determined

Not Likely

TABLE 6.2
CANCER TOXICITY DATA
FORMER SANF. HALATION
.GP

Chemical of Potential Concern	Unit Risk (mg/m ³) ⁻¹	Adjustment (1)	Inhalation Cancer Slope Factor	Weight of Evidence/ Cancer Guideline Description	Source	Date (2)
Acenaphthene	N/A	N/A	N/A	Not likely	N/A	N/A
Acenaphthylene	N/A	N/A	N/A	Not likely	N/A	N/A
Acetone	N/A	N/A	N/A	Not likely	N/A	N/A
Aluminum	N/A	N/A	N/A	Not likely	N/A	N/A
Antimony	N/A	N/A	N/A	Not likely	N/A	N/A
Arsenic	4.3E+00	x BW + IR	1.5E+01	Known/Likely/A	IRIS	Apr 1999
Barium	N/A	N/A	N/A	Known/Likely/B2	N/A	N/A
Benzene	8.3E-03	x BW + IR	2.9E-02	Known/Likely/A	IRIS	Apr 1999
Benzo(a)anthracene	N/A	N/A	3.1E-01	Known/Likely/B2	TEF	N/A
Benzo(a)pyrene	NF	N/A	3.1E+00	Known/Likely/B2	IRIS	Apr 1999
Benzo(b and/or k)fluoranthene	NF	N/A	3.1E-01	Known/Likely/B2	TEF	N/A
Benzo(b)fluoranthene	NF	N/A	3.1E-01	Known/Likely/B2	TEF	N/A
Benzo(k)fluoranthene	NF	N/A	3.1E-02	Known/Likely/B2	TEF	N/A
BHC, beta-	5.3E-01	x BW + IR	1.86E+00	Known/Likely/C	IRIS	Apr 1999
Butylbenzene, n-	N/A	N/A	N/A	Not likely	N/A	N/A
Butylbenzene, tert-	N/A	N/A	N/A	Not likely	N/A	N/A
Cadmium	1.8E+00	x BW + IR	6.3E+00	Known/Likely/B1	IRIS	Apr 1999
Chlordane, gamma-	1.0E-01	x BW + IR	3.5E-01	Known/Likely/B2	IRIS	Apr 1999
Chromium (III)	N/A	N/A	N/A	Not likely	N/A	N/A
Chromium (VI)	1.2E+01	x BW + IR	4.2E+01	Known/Likely/A	IRIS	Apr 1999
Chrysene	NF	N/A	3.1E-03	Known/Likely/B2	TEF	N/A
Cobalt	N/A	N/A	N/A	Not likely	N/A	N/A
Copper	N/A	N/A	N/A	Not likely	N/A	N/A
Cyanide	N/A	N/A	N/A	Not likely	N/A	N/A
Dibenzo(a,h)anthracene	NF	N/A	3.1E+00	Known/Likely/B2	TEF	N/A
Dibenzofuran	N/A	N/A	N/A	Not likely	N/A	N/A
Dichloroethane, 1,2-	2.6E-02	x BW + IR	9.1E-02	Known/Likely/B2	IRIS	Apr 1999
Dichloroethane, 1,1-	5.0E-02	x BW + IR	1.75E-01	Known/Likely/C	IRIS	Apr 1999
Dieldrin	4.6E+00	x BW + IR	1.6E+01	Known/Likely/B2	IRIS	Apr 1999
Ethylbenzene	N/A	N/A	N/A	Not likely	N/A	N/A
Fluoranthene	N/A	N/A	N/A	Not likely	N/A	N/A
Fluorene	N/A	N/A	N/A	Not likely	N/A	N/A
Indeno(1,2,3-c,d)pyrene	NF	N/A	3.1E-01	Known/Likely/B2	TEF	N/A
Iron	N/A	N/A	N/A	Not likely	N/A	N/A
Isopropylbenzene	N/A	N/A	N/A	Not likely	N/A	N/A
Lead	N/A	N/A	N/A	Not likely	N/A	N/A
Manganese	N/A	N/A	N/A	Not likely	N/A	N/A
Mercury	N/A	N/A	N/A	Not likely	N/A	N/A
Methyl-4,6-dinitrophenol, 2-	N/A	N/A	N/A	Not likely	N/A	N/A
Methylene chloride	4.7E-04	x BW + IR	1.6E-03	Known/Likely/B2	IRIS	Apr 1999

**TABLE 6 -
CANCER TOXICITY DATA
FORMER SANFL
HALATION
GP**

Chemical of Potential Concern	Unit Risk (mg/m ³) ⁻¹	Adjustment (1)	Inhalation Cancer Slope Factor	Weight of Evidence/ Cancer Guideline Description	Source	Date (2)
Methylnaphthalene, 1-	N/A	N/A	N/A	Not likely	N/A	N/A
Methylnaphthalene, 2-	N/A	N/A	N/A	Not likely	N/A	N/A
Naphthalene	N/A	N/A	N/A	Not likely	N/A	N/A
N-Nitrosodi-n-propylamine	NF	N/A	N/A	Not likely	N/A	N/A
Nitroaniline, 2-	N/A	N/A	N/A	Not likely	N/A	N/A
Nitroaniline, 4-	N/A	N/A	N/A	Not likely	N/A	N/A
Phenanthrene	N/A	N/A	N/A	Not likely	N/A	N/A
Propylbenzene, n-	N/A	N/A	N/A	Not likely	N/A	N/A
Pyrene	N/A	N/A	N/A	Not likely	N/A	N/A
Toluene	N/A	N/A	N/A	Not likely	N/A	N/A
Trimethylbenzene, 1,2,4-	N/A	N/A	N/A	Not likely	N/A	N/A
Trimethylbenzene, 1,3,5-	N/A	N/A	N/A	Not likely	N/A	N/A
Vanadium	N/A	N/A	N/A	Not likely	N/A	N/A
Xylenes, m&p-	N/A	N/A	N/A	Not likely	N/A	N/A
Xylenes, o-	N/A	N/A	N/A	Not likely	N/A	N/A
Xylenes, Total	N/A	N/A	N/A	Not likely	N/A	N/A
Zinc	N/A	N/A	N/A	Not likely	N/A	N/A

N/A=Not applicable.

NF=Not Found.

IRIS = Integrated Risk Information System

TEF=Benzo(a)pyrene Toxicity Equivalence Factor methodology

(1) Inhalation Unit Risk multiplied by body weight (BW; 70 kg)
and divided by inhalation rate (IR; 20m³/day).

(2) For IRIS values, the date IRIS was searched.

Cancer Group:

A - Human carcinogen

B1 - Probable human carcinogen - indicates that limited human data are available

B2 - Probable human carcinogen - indicates sufficient evidence in animals and
inadequate or no evidence in humans

C - Possible human carcinogen

D - Not classifiable as a human carcinogen

E - Evidence of no carcinogenicity

Weight of Evidence:

Known/Likely

Not Likely

LEAD MODEL CALCULATIONS

Exposure Equation J-1

Calculation of a Site-Specific RGO for Lead

$$PbS = \frac{(PbB_{a,c,g} - PbB_{a,0}) \times AT}{BKSF \times IR_s \times AF_s \times EF_s \times ED}$$

where,

for pregnancy considerations only,

$$PbB_{a,c,g} = \frac{PbB_{f,0.95,g}}{GSD_{i,a}^{1.645} \times R_{f/m}}$$

$$\text{and, } PbB_{f,0.95,g} = PbB_{a,c} \times GSD_{i,a}^{1.645} \times R_{f/m}$$

Exposure Parameter	Description	Pregnant Construction Worker Values
PbS	Soil lead concentration (appropriate average concentration for individual) expressed in ug/g (mg/kg; parts per million);	1,067
PbB _{a,c,g}	Goal for central estimate of blood concentration (ug/dL) in adults that have site exposures (default pregnant females value for Construction Worker);	3.70
PbB _{a,0}	Typical adult blood lead concentration (ug/dL) in the absence of site exposures [median of reported range (1.7-2.2 ug/dL), U.S. EPA, 1996];	1.95
AT	Averaging Time for exposure expressed in days;	122
BKSF	Biokinetic Slope Factor relating increase in typical adult blood lead concentration to average daily blood lead uptake (ug/dL per ug/day; default value, U.S. EPA, 1996);	0.4
IR _s	Intake Rate of soil expressed in g/day, including outdoor soil and indoor soil-derived dust (default value, U.S. EPA, 1996);	0.05
AF _s	Absolute gastrointestinal absorption fraction for ingested lead in soil and dust (dimensionless; default value, U.S. EPA, 1996);	0.12
EF _s	Exposure Frequency expressed in days/year (default);	250
ED	Exposure Duration (construction duration) expressed in years;	0.33
PbB _{f,0.95,g}	Goal for the 95th percentile blood lead concentration (ug/dL) among fetuses born to women having site exposures (default value, U.S. EPA, 1996);	10
GSD _{i,a}	Geometric Standard Deviation [dimensionless; median of reported range (1.8-2.1 ug/dL), U.S. EPA, 1996];	1.95
R _{f/m}	Constant of proportionality between fetal blood concentration at birth and maternal blood lead concentration (dimensionless; default value, U.S. EPA, 1996); and,	0.900
PbB _{a,c}	Central estimate of blood lead concentration (ug/dL) in adults that have site exposures [median of reported range (1.7-2.2 ug/dL), U.S. EPA, 1996].	1.95

Adapted from the U.S. EPA Technical Review Workgroup (TRW) Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil (U.S. EPA, 1996).

RISK ASSESSMENT SUMMARY

TABLE 10.1
RISK ASSESSMENT SUMMARY
REASONABLE MAXIMUM EXPOSURE
FORMER SANFORD MCP

Scenario Timeframe:	Current
Receptor Population:	Commercial Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Any on-site location	Arsenic	4.4E-06	-	7.0E-08	4.5E-06						
			Benzo(a)anthracene	3.3E-06	-	9.9E-07	4.3E-06						
			Benzo(a)pyrene	3.6E-05	-	1.1E-05	4.7E-05						
			Benzo(b and/or k)fluoranthene	1.3E-05	-	3.8E-06	1.6E-05						
			Benzo(b)fluoranthene	2.2E-06	-	6.5E-07	2.8E-06						
			Dibenzo(a,h)anthracene	4.4E-06	-	1.3E-06	5.8E-06						
			Indeno(1,2,3-c,d)pyrene	1.2E-06	-	3.6E-07	1.6E-06						
			(Total)	6.4E-05	-	1.8E-05	8.2E-05						
Surface Soil	Air	Any on-site location											
			(Total)	-	-	-							-
Total Risk Across Surface Soil							8.2E-05	Total Hazard Index Across Surface Soil					-

TABLE 10.
RISK ASSESSMENT SUMMARY
REASONABLE MAXIMUM EXPOSURE
FORMER SANFORD MGP

Scenario Timeframe:	Current
Receptor Population:	Commercial Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Any off-site location	Arsenic	4.5E-06	--	7.1E-08	4.6E-06						
			Benzo(a)anthracene	5.3E-05	--	1.6E-05	6.9E-05						
			Benzo(a)pyrene	5.7E-04	--	1.7E-04	7.5E-04						
			Benzo(b and / or k)fluoranthene	8.4E-05	--	2.5E-05	1.1E-04						
			Benzo(b)fluoranthene	8.6E-06	--	2.6E-06	1.1E-05						
			Dibenzo(a,h)anthracene	8.7E-06	--	2.6E-06	1.1E-05						
			Indeno(1,2,3-c,d)pyrene	1.0E-05	--	3.0E-06	1.3E-05						
			(Total)	7.4E-04	--	2.2E-04	9.6E-04						
Surface Soil	Air	Any off-site location	Benzo(a)pyrene	--	2.1E-06	--	2.1E-06	Methylnaphthalene, 2-Naphthalene	nasal	--	7.2E-01	--	7.2E-01
							nasal		--	5.2E-01	--	5.2E-01	
			(Total)	--	2.1E-06	--	2.1E-06		(Total)	--	--	--	1.2E+00
Total Risk Across Surface Soil							9.7E-04	Total Hazard Index Across Surface Soil					1.2E+00

Total nasal HI = 1.2E+00

TABLE 10.2a
RISK ASSESSMENT SUMMARY
REASONABLE MAXIMUM EXPOSURE
FORMER SANFORD MGP

Scenario Timeframe: Current
 Receptor Population: Trespasser/Visitor
 Receptor Age: Adolescent

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Any on-site location	Arsenic	2.2E-06	—	8.8E-09	2.2E-06						
			Benzo(a)anthracene	1.6E-06	—	1.2E-07	1.8E-06						
			Benzo(a)pyrene	1.8E-05	—	1.4E-06	1.9E-05						
			Benzo(b and/or k)fluoranthene	6.3E-06	—	4.7E-07	6.7E-06						
			Benzo(b)fluoranthene	1.1E-06	—	8.2E-08	1.2E-06						
			Dibenzo(a,h)anthracene	2.2E-06	—	1.7E-07	2.4E-06						
			(Total)	3.1E-05	—	2.2E-06	3.4E-05	(Total)	(Total)	—	—	—	—
Surface Soil	Air	Any on-site location											
			(Total)	—	—	—	—	(Total)	(Total)	—	—	—	—
Total Risk Across Surface Soil							3.4E-05	Total Hazard Index Across Surface Soil					—

**TABLE 10.
RISK ASSESSMENT (PRIMARY)
REASONABLE MAXIMUM EXPOSURE
FORMER SANFORD MCP**

Scenario Timeframe: Current
Receptor Population: Trespasser/Visitor
Receptor Age: Adolescent

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Any off-site location	Arsenic	2.2E-06	-	8.9E-09	2.2E-06						
			Benzo(a)anthracene	2.6E-05	-	2.0E-06	2.6E-05						
			Benzo(a)pyrene	2.9E-04	-	2.2E-05	3.1E-04						
			Benzo(b and/or k)fluoranthene	4.2E-05	-	3.2E-06	4.5E-05						
			Benzo(b)fluoranthene	4.3E-06	-	3.3E-07	4.6E-06						
			Dibenzo(a,h)anthracene	4.3E-06	-	3.3E-07	4.7E-06						
			Indeno(1,2,3-c,d)pyrene	5.0E-06	-	3.8E-07	5.3E-06						
			(Total)	3.7E-04	-	2.8E-05	4.0E-04						
	Air	Any off-site location											
			(Total)	-	-	-	-	(Total)	(Total)	-	-	-	-
Total Risk Across Surface Soil							4.0E-04	Total Hazard Index Across Surface Soil					-
Sediment	Sediment	Any off-site location	Benzo(a)pyrene	1.8E-06	-	1.4E-07	2.0E-06						
			(Total)	1.8E-06	-	1.4E-07	2.0E-06						
	Air	Any off-site location											
			(Total)	-	-	-	-	(Total)	(Total)	-	-	-	-
Total Risk Across Sediment							2.0E-06	Total Hazard Index Across Sediment					-
Total Risk Across All Media and All Routes							4.0E-04	Total Hazard Index Across All Media and All Routes					-

TABLE 10.3
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPC:
REASONABLE MAXIMUM EXPOSURE
FORMER SANFORD MGP

Scenario Timeframe: Future
 Receptor Population: Resident
 Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Any off-site location		NC	-	NC	NC	Antimony	blood	5.1E-01	-	6.4E-02	3.8E-01
				NC	-	NC	NC	Arsenic	skin	7.3E-01	-	1.5E-03	7.3E-01
				NC	-	NC	NC	Dibenzofuran	skin	6.0E-01	-	1.5E-02	6.2E-01
				NC	-	NC	NC	Fluoranthene	liver, kidney, blood	5.6E-01	-	2.2E-02	5.8E-01
				NC	-	NC	NC	Fluorene	blood	1.3E-01	-	3.2E-03	1.3E-01
				NC	-	NC	NC	Iron	GI	1.2E+00	-	2.9E-02	1.3E+00
				NC	-	NC	NC	Naphthalene	body weight	1.6E-01	-	3.1E-03	1.6E-01
				NC	-	NC	NC	Phenanthrene	body weight	1.2E+00	-	3.0E-02	1.2E+00
				NC	-	NC	NC	Pyrene	kidney	1.2E+00	-	4.6E-02	1.2E+00
			(Total)	NC	NC	NC	NC	(Total)	6.1E+00	-	2.1E-01	6.3E+00	
	Air	Any off-site location		-	NC	-	NC	Methylnaphthalene, 2-	nasal	-	3.0E+00	-	3.0E+00
				-	NC	-	NC	Naphthalene	nasal	-	2.1E+00	-	2.1E+00
			(Total)	-	NC	-	NC	(Total)	-	3.1E+00	-	3.1E+00	
Total Risk Across Surface Soil							NC	Total Hazard Index Across Surface Soil					1.1E+01

Total body weight HI =	1.4E+00	Total GI HI =	1.3E+00
Total blood HI =	1.1E+00	Total kidney HI =	1.8E+00
Total skin HI =	1.4E+00	Total nasal HI =	3.1E+00

TABLE 1
RISK ASSESSMENT SUMMARY
REASONABLE MAXIMUM EXPOSURE
FORMER SANFORD MGP

Scenario Timeframe: Future
 Receptor Population: Resident
 Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Any off-site location											
			(Total)	-	-	-	-		(Total)	-	-	-	-
Surface Soil	Air	Any off-site location						Methylnaphthalene, 2-Naphthalene	nasal	-	1.0E+00	-	1.0E+00
			(Total)	-	-	-	-		nasal	-	7.5E-01	-	7.5E-01
									(Total)	-	1.8E+00	-	1.8E+00
Total Risk Across Surface Soil							NC	Total Hazard Index Across Surface Soil					1.8E+00
												Total nasal HI =	1.8E+00

**TABLE 10:
RISK ASSESSMENT SUMMARY
REASONABLE MAXIMUM EXPOSURE
FORMER SANFORD MGP**

Scenario Timeframe:	Future
Receptor Population:	Resident
Receptor Age:	Aggregate

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Any on-site location	Arsenic	2.1E-05	-	1.5E-07	2.1E-05						
			Benzo(a)anthracene	1.6E-05	-	2.1E-06	1.6E-05						
			Benzo(a)pyrene	1.7E-04	-	2.3E-05	2.0E-04						
			Benzo(b and/or k)fluoranthene	6.0E-05	-	8.0E-06	6.8E-05						
			Benzo(b)fluoranthene	1.0E-05	-	1.4E-06	1.2E-05						
			Dibenzo(a,h)anthracene	2.1E-05	-	2.8E-06	2.4E-05						
			Indeno(1,2,3-c,d)pyrene	3.7E-06	-	7.6E-07	6.5E-06						
			(Total)	3.1E-04	-	3.8E-05	3.4E-04	(Total)	(Total)	-	-	-	-
	Air	Any on-site location											
			(Total)	-	-	-	-	(Total)	(Total)	-	-	-	-
Total Risk Across Surface Soil							3.4E-04	Total Hazard Index Across Surface Soil					-

TABLE 10.5¹
RISK ASSESSMENT SUMMARY
REASONABLE MAXIMUM EXPOSURE
FORMER SANFORD MGP

Scenario Timeframe:	Future
Receptor Population:	Resident
Receptor Age:	Aggregate

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Any off-site location	Arsenic	2.2E-05	-	1.5E-07	2.2E-05						
			Benzo(a)anthracene	2.5E-04	-	3.4E-05	2.9E-04						
			Benzo(a)pyrene	2.7E-03	-	3.7E-04	3.1E-03						
			Benzo(b and/or k)fluoranthene	4.0E-04	-	5.4E-05	4.6E-04						
			Benzo(b)fluoranthene	4.1E-05	-	5.5E-06	4.7E-05						
			Benzo(k)fluoranthene	1.1E-06	-	1.5E-07	1.2E-06						
			Chrysene	2.5E-06	-	3.3E-07	2.8E-06						
			Dibenzo(a,h)anthracene	4.2E-05	-	5.6E-06	4.7E-05						
			Indeno(1,2,3-c,d)pyrene	4.8E-05	-	6.4E-06	5.4E-05						
			(Total)	3.6E-03	-	4.7E-04	4.0E-03						
	Air	Any off-site location	Benzo(a)pyrene	-	4.0E-06	-	4.0E-06						
			(Total)	-	4.0E-06	-	4.0E-06						
Total Risk Across Surface Soil							4.0E-03	Total Hazard Index Across Surface Soil					-

TABLE 10.6a
RISK ASSESSMENT SUMMARY
REASONABLE MAXIMUM EXPOSURE
FORMER SANFORD MGP

Scenario Timeframe: Future
 Receptor Population: Construction Worker
 Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Any on-site location	Benzo(a)pyrene	1.9E-06	--	5.6E-07	2.4E-06	(Total)	(Total)	--	--	--	--
			(Total)	1.9E-06	--	5.6E-07	2.4E-06						
	Air	Any on-site location					(Total)	(Total)	--	--	--	--	
			(Total)	--	--	--							--
Total Risk Across Surface Soil							2.4E-06	Total Hazard Index Across Surface Soil					--
Groundwater	Groundwater	Any on-site location					(Total)	Benzene	CNS, blood	1.3E-01	--	1.8E+00	1.9E+00
			(Total)	--	--	--				--	1.3E-01	--	1.8E+00
	Air	Any on-site location					(Total)	(Total)	--	--	--	--	
			(Total)	--	--	--							--
Total Risk Across Groundwater							--	Total Hazard Index Across Groundwater					1.9E+00
Total Risk Across All Media and All Routes							2.4E-06	Total Hazard Index Across All Media and All Routes					1.9E+00

Total CNS HI = 1.9E+00

TABLE 10.6b
RISK ASSESSMENT SUMMARY
REASONABLE MAXIMUM EXPOSURE
FORMER SANFORD MGP

Scenario Timeframe: Future
 Receptor Population: Construction Worker
 Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient									
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total					
Surface Soil	Surface Soil	Any off-site location	Benzo(a)anthracene	2.8E-06	-	8.2E-07	3.6E-06	Iron	GI	1.8E-01	-	3.2E-02	2.1E-01					
			Benzo(a)pyrene	3.0E-05	-	8.9E-06	3.9E-05											
			Benzo(b and/or k)fluoranthene	4.4E-06	-	1.3E-06	5.7E-06											
			(Total)	3.7E-05	-	1.1E-05	4.8E-05											
	Air	Any off-site location					Methylnaphthalene, 2-Naphthalene	nasal	-	1.1E+00	-	1.1E+00						
			(Total)	-	-	-							(Total)	-	8.1E-01	-	8.1E-01	
Total Risk Across Surface Soil							4.8E-05	Total Hazard Index Across Surface Soil							2.2E+00			
Subsurface Soil	Subsurface Soil	Any off-site location	Arsenic	6.6E-05	-	4.9E-09	6.6E-05	Iron	GI	8.3E-01	-	1.4E-01	9.7E-01					
			Benzo(a)anthracene	3.9E-05	-	5.5E-08	3.9E-05											
			Benzo(a)pyrene	2.8E-04	-	3.9E-07	2.8E-04											
			Benzo(b and/or k)fluoranthene	2.4E-05	-	3.4E-06	2.4E-05											
			Benzo(b)fluoranthene	2.0E-05	-	2.8E-08	2.0E-05											
			Dibenz(a,h)anthracene	8.6E-05	-	1.2E-07	8.6E-05											
			Indeno(1,2,3-c,d)pyrene	2.1E-05	-	3.0E-08	2.1E-05											
	(Total)	5.3E-04	-	6.7E-07	5.3E-04	(Total)	8.3E-01	-	1.4E-01	9.7E-01								
	Air	Any off-site location																
			(Total)	-	-	-	-	(Total)	-	-	-	-						
Total Risk Across Subsurface Soil							5.3E-04	Total Hazard Index Across Subsurface Soil							9.7E-01			
Sediment	Sediment	Any off-site location																
			(Total)	-	-	-	-	(Total)	-	-	-	-						
	Air	Any off-site location																
			(Total)	-	-	-	-	(Total)	-	-	-	-						
Total Risk Across Sediment							-	Total Hazard Index Across Sediment							-			
Groundwater	Groundwater	Any off-site location					Iron	GI	2.3E-02	-	1.6E-01	1.8E-01						
													Naphthalene	body weight	8.0E-02	-	3.2E+00	3.3E+00
			(Total)	-	-	-							-	(Total)	1.0E-01	-	3.4E+00	3.5E+00
	Air	Any off-site location					Naphthalene	nasal	-	2.1E+00	-	2.1E+00						
			(Total)	-	-	-							-	(Total)	-	2.1E+00	-	2.1E+00
Total Risk Across Groundwater							-	Total Hazard Index Across Groundwater							5.6E+00			
Total Risk Across All Media and All Routes							5.8E-04	Total Hazard Index Across All Media and All Routes							7.8E+00			

Total body weight HI = 3.3E+00
 Total nasal HI = 4.1E+00
 Total GI HI = 1.6E+00

TABLE 10.1
RISK ASSESSMENT **MARY**
REASONABLE MAXIMUM EXPOSURE
FORMER SANFORD MGP

Scenario Timeframe:	Future
Receptor Population:	Other Worker (Irrigation Maint)
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient						
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total		
Groundwater	Groundwater	Any on-site location	Benzene	2.6E-07	--	3.5E-06	3.8E-06								
			(Total)	2.6E-07	--	3.5E-06	3.8E-06							(Total)	(Total)
	Air	Any on-site location	Benzene	--	1.7E-06	--	1.7E-06								
			(Total)	--	1.7E-06	--	1.7E-06							(Total)	(Total)
Total Risk Across Groundwater							5.4E-06	Total Hazard Index Across Groundwater							--

APPENDIX D: COST TABLES

**Cost Estimate Alternative 2
Institutional Controls
Sanford Gasification Plant**

Item	Quantity	Units	Unit Cost	Cost	
				Capital	Annual
Institutional Controls					
Enacting deed restrictions/zoning control	1	LS	\$30,000	\$30,000	
Annual inspections	1	year	\$1,200		\$1,200
Contingency (25%)				\$7,500	\$300
Total				\$37,500	\$1,500
Present Worth (i = 5%, n = 33 years)					\$61,504

**Cost Estimate Alternative 3
Monitoring and Natural Attenuation
Sanford Gasification Plant**

Item	Quantity	Units	Unit Cost	Cost	
				Capital	Annual
Monitoring					
Analytical (annual average unit cost)	9	well	\$600		\$5,400
Sampling and reporting labor	5	day	\$1,770		\$8,850
Expenses (travel, equipment rental, per diem)	1	LS	\$1,000		\$1,000
Data evaluation, modeling and remedy review (annual average unit cost)	1	LS	\$2,500		\$2,500
Well installation	4	each	\$2,000	\$8,000	
Subtotal				\$8,000	\$17,750
Contingency (25%)				\$2,000	\$4,438
Total				\$10,000	\$22,188
Present Worth (i = 5%, annual costs occur in years 1-7, 9, 11, 13, 15, 17, 19, 21, 23, 25, 27, 29-33)					\$248,749
Institutional Controls					
Enacting deed restrictions/zoning control	1	LS	\$30,000	\$30,000	
Annual inspections	1	year	\$1,200		\$1,200
Subtotal				\$30,000	\$1,200
Contingency (25%)				\$7,500	\$300
Total				\$37,500	\$1,500
Present Worth (i = 5%, n = 33 years)					\$24,004
Total Present Worth					\$320,252

Cost Estimate Alternative 4
Air Sparging and Soil Vapor Extraction
Sanford Gasification Plant

Item	Quantity	Units	Unit Cost	Cost	
				Capital	Annual
Monitoring					
Analytical	9	well	\$600		\$5,400
Sampling and reporting labor	5	day	\$1,770		\$8,850
Expenses (travel, equipment rental, per diem)	1	LS	\$1,000		\$1,000
Data evaluation, modeling and remedy review (annual average unit cost)	1	LS	\$2,500		\$2,500
Well installation	4	each	\$2,000	\$8,000	
Institutional Controls					
Enacting deed restrictions/zoning control	1	LS	\$30,000	\$30,000	
Annual inspections	1	LS	\$1,200		\$1,200
Subtotal				\$38,000	\$18,950
Contingency (25%)				\$9,500	\$4,738
Total				\$47,500	\$23,688
Present Worth (i = 5%, n = 17 years)					\$267,055
Air Sparging and Soil Vapor Extraction					
Permitting/design/bidding/contracting	1	LS	\$50,000	\$50,000	
Pilot testing	1	LS	\$25,000	\$25,000	
Mobilization/demobilization	1	LS	\$15,000	\$15,000	
Injection points	45	EA	\$750	\$33,750	
Air sparge and extraction system	1	LS	\$70,000	\$70,000	
Recovery trench installation	150	LF	\$250	\$37,500	
Exhaust air treatment (1 year)	1	LS	\$30,000	\$30,000	
Air sparge/extraction system O&M	1	year	\$65,000		\$65,000
Subtotal				\$261,250	\$65,000
Contingency (25%)				\$65,313	\$16,250
Total				\$326,563	\$81,250
Present Worth (i = 5%, years 7 through 12)				\$232,088	\$307,743
Total Present Worth					\$854,386

Cost Estimate Alternative 5
Groundwater Pump and Treat
Sanford Gasification Plant

Item	Quantity	Units	Unit Cost	Cost	
				Capital	Annual
Monitoring					
Analytical	9	well	\$600		\$5,400
Sampling and reporting labor	5	day	\$1,770		\$8,850
Expenses (travel, equipment rental, per diem)	1	LS	\$1,000		\$1,000
Data evaluation, modeling and remedy review (annual average unit cost)	1	LS	\$2,500		\$2,500
Well installation	4	each	\$2,000	\$8,000	
Institutional Controls					
Enacting deed restrictions/zoning control	1	LS	\$30,000	\$30,000	
Annual inspections	1	LS	\$1,200		\$1,200
Subtotal				\$38,000	\$18,950
Contingency (25%)				\$9,500	\$4,738
Total				\$47,500	\$23,688
Present Worth (i = 5%, n = 24 years)					\$326,854
Groundwater Pump-and-Treat System					
Permitting/design/bidding/contracting	1	LS	\$35,000	\$35,000	
Pilot Testing	1	LS	\$40,000	\$40,000	
Recovery & treatment systems	1	LS	\$120,000	\$120,000	
Annual discharge fees	25,229	1,000 gallon	\$3.31		\$83,508
Annual O&M (includes site inspection)	1	year	\$30,000		\$30,000
Subtotal				\$195,000	\$113,508
Contingency (25%)				\$48,750	\$28,377
Total				\$243,750	\$141,885
Present Worth (i = 5%, years 7 through 24)				\$173,233	\$1,237,649
Total Present Worth					\$1,785,236

**APPENDIX E: LETTER APPROVING
ECOLOGICAL RISK ASSESSMENT COMPENDIUM
STEPS 2 AND 3 FOR SOILS**



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
 REGION 4
 ATLANTA FEDERAL CENTER
 61 FORSYTH STREET
 ATLANTA, GEORGIA 30303-8960

March 8, 2001

WMS-SSMB

VIA FACSIMILE

FILE COPY

George F. Gramling, III
 Attorney at Law
 Sanford Group
 601 North Ashley Drive
 Suite 600
 Tampa, FL 33602

Subject: Sanford Gasification Plant Site
 Operable Unit One (OU1) Ecological Risk Assessment Report

Dear Mr. Gramling:

The Environmental Protection Agency (EPA) has reviewed the EHI, Inc. Ecological Risk Assessment Compendium - Step 1 for all Media and Steps 2 and 3 for Soil dated February 15, 2001. The document is acceptable for the completion of the ecological risk assessment for soils at the Sanford Coal Gasification Site, based on the assumption that the excavation of soils will take place and that the soil will be replaced by clean fill. If this remediation does not take place, the ecological risk assessment should be readdressed. Under this assumption the ecological risk assessment for soils is hereby approved.

EPA would like the Sanford Group to continue working on the ecological risk assessment for the other media. EPA would like the Group to submit Step 3, Problem Formulation up to refinement of Chemicals of Potential Concern (COPCs), by May 15, 2001.

If you have any questions you can contact me at (404) 562-8948.

Sincerely,

/ Carmen J. Santiago-Ocasio
 Remedial Project Manager
 South Site Management Branch

cc: Guy Kaminski, GEI Consultants, Inc.
 Garnett Craig, FPC

APPENDIX F: INSTITUTIONAL CONTROLS

GROUNDWATER USE ADVISORY ZONE (GUAZ)

PROPERTY OWNERSHIP - CITY OF SANFORD ⁵⁹⁰¹²⁷

A FPUC
3 CITY OF SANFORD
C CSX
D CPM
E CODISCO



STREAM (CBC & UT)



APPROXIMATE EXTENT OF GW IMPACTS

